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The Engineer

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For Sale.—Four DISMANTLED HYDRAULIC PRESSES for general purposes, with Intensifier. Designed for a pressure of 700 lb. per square inch, or an intensified pressure of 3360 lb. per square inch, complete with interconnecting pipes and operating valves.

Size of press tables	2ft. by 3ft.
Clear height for goods	4ft. 6in.
Diam. of press ram	6in.
Stroke of ditto	3ft.

Constructed by the Hydraulic Eng. Co., Ltd., Chester, about 1893.
All in good serviceable condition.
May be seen at the INDIA STORE DEPARTMENT, Belvedere-road, Lambeth, London, S.E. 1, between 10 a.m. and 5 p.m. (Saturday, 1 p.m.). 6920

Royal Corps of Naval CONSTRUCTORS.
A COMPETITIVE EXAMINATION for a POST as PROBATIONARY ASSISTANT CONSTRUCTOR will be held at the Royal Naval College, Greenwich, during the first fortnight in July next.

Candidates must not be more than 24 years of age on 1st October next, and must then have been engaged in practical shipbuilding work for at least 18 months. Graduates from the Universities are preferred.

The salaries and other conditions of service are given in full in the regulations of the Royal Corps of Naval Constructors. The salaries during the two or three years' Greenwich course, including cost-of-living bonus reckoned at its present rate of 55, are approximately as follows :—

Probationary Assistant Constructors on joining R.N. College, £177 in addition to mess allowance.
Probationary Assistant Constructors during second half of course, £202 in addition to mess allowance.

Candidates successful at the end of the R.N. College course will be admitted into the Royal Corps of Naval Constructors as permanent Civil Servants, with corresponding superannuation and other privileges, the salaries, including bonus as above, of the lower grades being approximately as follows :—

2nd Class Assistant Constructor (first 3 years), £301-£337.
1st Class Assistant Constructor (after 3 years), £408, rising to £680.

The salaries, &c., for the higher grades are stated in the regulations, which may be obtained from the SECRETARY OF THE ADMIRALTY (C.E. Branch), Whitehall, S.W. 1, to whom intending candidates must submit their names and full particulars of their educational and technical training and practical experience not later than the 23rd proximo.

PRIVATE STUDENTS OF NAVAL ARCHITECTURE.
A QUALIFYING EXAMINATION will be held in conjunction with the above, for the admission to the Royal Naval College, Greenwich, of PRIVATE STUDENTS of NAVAL ARCHITECTURE who desire to receive instruction in the course laid down for PROBATIONARY ASSISTANT CONSTRUCTOR. Applications for admission as Private Students should reach the SECRETARY OF THE ADMIRALTY (C.E. Branch) not later than the 23rd proximo.

Private Students are required to pay a fee of £50 per session.

Applications for the regulations should be accompanied by an addressed foolscap envelope. 6829

Administrative County of LONDON.
ROBERT BLAIR FELLOWSHIPS IN APPLIED SCIENCE AND TECHNOLOGY.

The London County Council invites APPLICATIONS for the AWARD of TWO ROBERT BLAIR FELLOWSHIPS in APPLIED SCIENCE and TECHNOLOGY, each of the value of £450, tenable for one year. The Fellowships are for advanced study or research in applied science and technology and will be tenable in the Dominions, the United States, or other foreign countries.

Candidates must be British subjects and at least twenty-one years of age.

Further particulars and application forms may be obtained from the Education Officer (T.3), The County Hall, S.E. 1 (stamped addressed foolscap envelope necessary), to whom the form must be returned by 18th June, 1931.

MONTAGU H. COX.
6931 Clerk of the London County Council.

Armstrong College,
NEWCASTLE-UPON-TYNE.
(IN THE UNIVERSITY OF DURHAM.)

COURSES for the PASS DEGREE of B.Sc. and the HONOURS DEGREE of B.Sc. in MECHANICAL, MARINE, CIVIL or ELECTRICAL ENGINEERING, MINING, METALLURGY, or NAVAL ARCHITECTURE. The curricula of the Pass Degree and the Honours Degree normally occupy periods of three and four years respectively, but candidates presenting evidence of sufficient previous training may be allowed to proceed to either Degree after two years' residence.

The engineering laboratories have recently been extended, and all Departments are equipped for advanced tutorial and research work.

Full particulars of the Courses may be had on application to

THE REGISTRAR,
Armstrong College,
6289 Newcastle-upon-Tyne.

University of Bristol.
FACULTY OF ENGINEERING.

The UNIVERSITY invites APPLICATIONS for the following POSTS :—

A LECTURESHIP in METALLURGY (Grade II.). Salary £400 to £500, according to qualifications.
An ASSISTANT LECTURESHIP in CIVIL ENGINEERING (Grade III.). Salary £300.
An ASSISTANT LECTURESHIP in ELECTRICAL ENGINEERING (Grade III.). Salary £300.
An ASSISTANT LECTURESHIP in MATHEMATICS (Grade III.). Salary £300.

Applications should reach the undersigned, from whom further particulars may be obtained, on or before Tuesday, June 9th, 1931.

WINIFRED SHAPLAND,
6940 Secretary and Acting Registrar.

PUBLIC NOTICES

Administrative County of LONDON.

The London County Council invites TENDERS for the EXECUTION of the undermentioned WORKS, viz.:—

ALTERATIONS and ADDITIONS to existing FORCED CIRCULATION HEATING SYSTEM, &c., at South-Eastern Hospital, New Cross, S.E.

The specification, form of Tender, &c., may be obtained on application to the Chief Engineer, The Old County Hall, Spring-gardens, S.W. 1, on and after Wednesday, 6th May, 1931, upon payment of £1 by cheque, draft or money order to the order of the London County Council.

This amount will be returnable only if the tenderer shall have sent in a bona fide Tender and shall not have withdrawn the same. Full particulars of the work may be obtained on personal application and the contract documents may be inspected before payment of the fee.

Remittances by post should be addressed to the Chief Engineer, The Old County Hall, Spring-gardens, S.W. 1. Personal inquiries at Room 2, No. 3, Warwick House-street, Cockspur-street, S.W. 1.

The contractor will be bound to observe the provisions of a fair wages clause, the terms of which are set out fully in the instructions for Tender and form of contract and in "The London County Council Gazette."

No Tender received by the Clerk of the Council at the County Hall, Westminster Bridge, S.E. 1, after 4 p.m. on Friday, 22nd May, 1931, will be considered.

The Council does not bind itself to accept the lowest or any Tender.

MONTAGU H. COX.
6929 Clerk of the London County Council.

Eastleigh and Bishopstoke SEWERAGE.
CONTRACT NO. 2.

TENDERS will shortly be advertised for the SUPPLY, DELIVERY and ERECTION of ELECTRICALLY DRIVEN SEWAGE PUMPING UNITS, including GENERATING PLANT, ELECTRICAL CABLES, &c. Contractors experienced in this class of work are invited to send in their names to A. P. I. COTTERELL and SON, Chartered Civil Engineers, 54, Victoria-street, Westminster, S.W. 1. 6937

PUBLIC NOTICES

Borough of Harwich.
MAIN DRAINAGE.
CONTRACT NO. 2.

TO BRITISH MANUFACTURERS OF NON-CHOKEABLE CENTRIFUGAL PUMPING PLANT.

The Council is prepared to receive TENDERS for the SUPPLY and ERECTION of an ELECTRICALLY DRIVEN HORIZONTAL NON-CHOKEABLE PUMP, capable of pumping crude sewage, to be installed in the existing Fernlea-road Sewage Pumping Station. The works included in the contract consist of the manufacture, supply and erection of an electric motor with starting gear and cables, a non-chokeable pump with all pipes and valves inside the house, and also an electrically driven air exhausting apparatus, all in accordance with the drawing, general conditions and specification prepared by the Engineers, Messrs. John Taylor and Sons, Caxton House, Westminster, S.W. 1.

The general conditions, specification and a copy of the drawing may be obtained by the manufacturer from the offices of the Engineers upon payment of £5 (cheque only), which will be returned upon receipt of a bona fide Tender.

The works are being expedited for the relief of the unemployed, and the contract will be subject to special conditions laid down by the Unemployment Grants Committee.

Tenders, in sealed envelopes, endorsed "Tender for Sewage Pumping Plant, Contract No. 2," must be delivered at my office at Harwich on or before 10 a.m. on Thursday, the 28th May, 1931.

The Council does not bind itself to accept the lowest or any Tender.

By Order,
(Signed) A. J. WARD,
Town Clerk.
Town Clerk's Office, Harwich. 6928

The Tralee and Fenit Pier and Harbour Commissioners invite TENDERS for the SUPPLY and ERECTION of a LOCOMOTIVE STEAM CRANE at Fenit in accordance with specification, copy of which can be had on application to the undersigned.

Sealed Tenders to reach me not later than Monday, 18th inst.

The lowest or any Tender not necessarily accepted.

J. LAWLOR,
Harbour Offices, Tralee, Secretary.
May 4th, 1931. 6948

PUBLIC NOTICES

County Borough of NORTHAMPTON.
HIGHWAYS AND FARM AND SEWAGE DISPOSAL COMMITTEES.

TENDERS are INVITED by the Corporation from competent Public Works Contractors for the CONSTRUCTION of the several WORKS included in the following Contracts :—

CONTRACT NO. 1 (SECTION A).
Construction of Automatic Pumping Station at Bedford-road, Northampton, with Storm Water Sump for the Installation of No. 2, 10in., and No. 2, 12in. Centrifugal Pumps.
(SECTION B).
Construction of 1¼ Miles of 5ft. diameter Main Outfall Conduit (Concrete Tube).
700 Yards of 3ft. 9in. diameter Storm Water Conduit with Storm Water Weirs, &c.
CONTRACT NO. 2.
Construction of Sewage Disposal Works, consisting of Detritus Tanks, Screening Chamber, Dortmund Tanks, Humus Tanks, and Main Effluent Carriers, &c., at Great Billing, near Northampton.
CONTRACT NO. 3.
ST. JAMES' DISTRICT MAIN DRAINAGE.
Construction of approximately 950 Lineal Yards of Cast Iron Pipe Sewers, varying in size from 30in. to 42in. diameter; also 2880 Lineal Yards of Concrete Tube Sewers, 18in. to 42in. diameter.
Construction of Pumping Station, including Machinery, &c., Rising Mains, and Sewage Tank.
CONTRACT NO. 4.
FAR COTTON DISTRICT MAIN DRAINAGE.
Construction of approximately 2046 Lineal Yards of Cast Iron Pipe Sewers, 21in. to 33in. diameter.

Plans may be inspected at the office of the Borough Engineer, Mr. Alfred Fidler, M. Inst. C.E., Borough Engineer, Guildhall, Northampton, from whom forms of Tender, specification and bills of quantities may be obtained, on and after May 6th, 1931, on deposit of Five Pounds for each of the four Contracts (crossed cheques made payable to "Northampton Corporation"), and which deposits will be returned upon receipt of a bona fide Tender in each case, and of all the documents forwarded to the Contractor for the purpose of preparing his Tenders.

With the exception of Contract No. 1 (Main Outfall), &c., the Contractors carrying out the work will be required to comply with the regulations of the Unemployment Grants Committee with regard to the employment of labour during the performance of the Contract.

Sealed Tenders, upon the forms provided, must be received by the undersigned not later than 10 a.m. on Wednesday, the 27th May, 1931, endorsed "Main Sewerage and Sewage Disposal Works," with the number of Contract to which the Tender applies.

The Corporation do not bind themselves to accept the lowest or any Tender, nor to pay any expenses incurred by persons tendering.

W. R. KEW,
Town Clerk.
Guildhall, Northampton,
April 27th, 1931. 6828

Wanted by Large Municipality in Yorkshire, the following EXCAVATING and 2ft. GAUGE LIGHT RAILWAY PLANT, in very good condition :—

One Power Excavating Shovel, ¾ or 1 cu. yd. Bucket, preferably Internal Combustion Engine-driven, and with Caterpillar Travelling Gear.
One Head Gear with Foot and Hand Screw-operated Brakes for Self-acting Incline, capable of dealing with loads of 30 to 45 tons down and 10 to 20 up an incline 700ft. long—maximum 1 in 3½.
One Mile 2ft. Track, 20 to 35 lb. Rails, with Turnouts and Fittings.
Four 20 to 30 H.P. Tractors, or Light Locos.
Sixty 27 to 36 cu. ft. Heavy Type Tip Wagons, for use with the above.

Particulars and offers to be submitted to 6922, The Engineer Office. 6922

Metropolitan Water Board.
APPOINTMENT OF ENGINEERING SUPERINTENDENT OF WORKS.

The Metropolitan Water Board invite APPLICATIONS from resident engineers, civil engineering contractors' agents, and others, in respect of the APPOINTMENT of an ENGINEERING SUPERINTENDENT of WORKS, in the Chief Engineer's Department, at a commencing salary of £350 per annum, rising by four annual increments, subject to the Certificate of the Chief Engineer, to £425 per annum, and thereafter at the discretion of the Board.

Applicants must have had experience in the control of workmen, and in the laying of water mains and communication pipes in streets. The successful candidate will be required to devote his whole time to the service of the Board; to reside in a house provided by the Board in Holloway, London, N.; and to pay in respect of such occupation a rental to be determined by the Board; to pass satisfactorily a medical examination by the Board's Chief Medical Officer; and to undertake in writing to join the Board's Superannuation and Provident Fund.

Applications, in the candidates' own handwriting, stating age and full particulars of education, training and qualifications, should be addressed to Mr. Henry E. Stilgoe, M. Inst. C.E., the Chief Engineer, and must reach the offices of the Board not later than the 22nd May, 1931.

Canvassing will be held to be a disqualification.

G. F. STRINGER,
Clerk of the Board.
Offices of the Board,
173, Rosebery-avenue, E.C. 1,
6th May, 1931. 6938

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For Advertisement Rates see Leader Page.

SITUATIONS OPEN

COPIES OF TESTIMONIALS, NOT ORIGINALS, UNLESS SPECIFICALLY REQUESTED.

WANTED by Leading Engineering Insurance Company, ADDITIONAL INSPECTORS, fully qualified in best Crane and Lift Practice. Age 28 to 32. Commencing salary £260 per annum.—Address, with full particulars of experience, age, &c., 6949, The Engineer Office. 6949 A

CHIEF INSPECTOR REQUIRED for Large Automobile Body Manufacturers in South Midlands; good general and technical education essential; must have had sound Workshop experience, and have spent a number of years in an executive capacity, specialising in the Design and Manufacture of all Steel Auto. Bodies and Component Pressings. Excellent opportunities for the right type of man.

Applications, which should give age and fullest particulars of previous positions held and salary required, will be treated in strict confidence.

Also state if at present in employment.

Address, 6954, The Engineer Office. 6954 A

EFFICIENCY MAN REQUIRED, South Midlands. Expert in Simplifying and Improving Operations in Jigging and Assembling Methods. Preference given to man with actual experience of the Salvage and use of Scrap Metal. Splendid prospects for the right type of man. Must be very energetic and understanding all processes of manufacturing.

Write, stating age, full particulars of past experience and salary required.

Address, 6955, The Engineer Office. 6955 A

GAS ENGINEER, with Exp. Horizontal Retorts and C.W.G. Plant, REQD. for Brazil. Age 25/38, single pref. £350 p.a.—Apply, LAURIE and CO., Employment Specialists, 28, Basinghall-street, E.C. 2. No preliminary fee. P1060 A

PRESS SHOP SUPERINTENDENT.—REQUIRED IMMEDIATELY, a fully qualified SUPERVISOR with a thorough theoretical training and first-class experience on high-grade Automobile Body Stampings, Chassis Frames, and Miscellaneous Pressed Steel Components. Only men accustomed to Motor-driven Power Presses, single and double action, need apply. Exceptional opportunities for the right type of man.

Applications, which should give age and full particulars of training, previous situations held, and salary required, will be treated in strict confidence.

Also state if at present in employment.

Address, 6956, The Engineer Office. 6956 A

SUPERINTENDENT to TAKE COMPLETE CHARGE of PAINT and TRIMMING DEPARTMENTS, manufacturing Automobile Bodies. Applications only entertained of men who have worked in a similar capacity, used to high-grade work and fully conversant with Mass Production Methods. Permanent and remunerative position for man with the necessary qualifications.—Address in confidence, stating age and full particulars of previous experience, 6957, The Engineer Office. 6957 A

WANTED, YOUNG DRAUGHTSMAN, with Technical training, to assist Agent; one used to Contractors' Mechanical and Electrical Work on Public Works preferred.—Apply by letter, stating age, experience and salary required, to Sir LINDSAY PARKINSON and CO., Ltd., Robinson-lane, Grimsby. 6953 A

A WELL-KNOWN London Firm of Heating Engineers REQUIRES ASSISTANT DRAUGHTSMAN. Must have had experience in all forms of heating and ventilating work

Address, stating experience, age and salary required, 6947, The Engineer Office. 6947 A

QUICK and Neat JUNIOR DETAILING DRAUGHTSMEN REQUIRED by London Constructional Engineers. Salary offered £3 10s. to £4. Particulars of previous experience, including age, in confidence.—Address, 6950, The Engineer Office. 6950 A

REQUIRED IMMEDIATELY

• • •

Assistant Works Manager

for a large firm in the West of England.

Must have good knowledge of internal combustion engines and the producing of small precision parts.

Applicants for this position must not be under 25 or over 35, and must state full particulars of their previous experience.

Progressive position to man who can make good.

Applications will be treated with strict confidence.

Address, **6936, The Engineer Office.** 6936

SITUATIONS WANTED

ABILITY! ENERGY! COMPETENCE!—Young MECHANICAL ENGINEER (25), 1st class training, 8 years shop and D.O. exp. in loco. and general engineering, Higher Grade National Cert., Assoc. Manchester College of Tech., DESIRES PROGRESSIVE POSITION at home or abroad.—Address, P1061, The Engineer Office. P1061 B

A.M.I.M.E. (28), Returned from 4 Years' Contract in Far East, DESIRES POST as Representative abroad to engineering concern. Sound education, training, and experience. Good French.—Address, P1062, The Engineer Office. P1062 B

CAN Any BROTHER MASON OFFER POST to ERECTION and MAINTENANCE ENGINEER. Good practical experience with gas, steam and oil engines, boilers, pumping machinery, gasworks plant, and coke ovens. Age 30. Highest references.—Address, P1063, The Engineer Office. P1063 B

ENGINEER (28), Educated at Public School and Cambridge, 2 years' experience in steel and general engineering, 2½ years in oil engines, SEEKS POST in works or on the commercial side.—Address, P1051, The Engineer Office. P1051 B

ENGINEER, M.I. Mech. E., Age 41. Expert on modern steam-raising installations and accessories, condensing plants, iron and steel works plant, grit catchers, considerable experience in boiler-making, ironfounding, machine shops, repair work, sales, estimating, technical, commercial, DESIRES EXECUTIVE POST. At liberty after June 1st.—Address, P1059, The Engineer Office. P1059 B

ENGINEER, 27 Years of Age. Experience with electrical, Diesel and steam plant, SEEKS OPENING where he would have time to study for I.E.E. exam. Now working seven days a week.—Address, P1047, The Engineer Office. P1047 B

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Fee 21/- per week, or as may be arranged, and travelling expenses.

Particulars can be obtained from the Secretary:—

116, Victoria Street, Westminster, LONDON, S.W.1.

SITUATIONS WANTED (continued)

ENGINEER, with Home and Continental Mechan. and Electr. experience, pumping specialist, SEEKS CHANGE as Chief of existing Centrifugal and Turbo Pump Dept., or to introduce these specialties to a good firm. Excellent references.
Address, P1046, The Engineer Office. P1046 B

ENGINEER'S BUYER, Age 47, Shortly Disengaged, SEEKS NEW ENGAGEMENT. Excellent credentials, over 20 years' buying experience; also several years stores, with up-to-date methods. Wide knowledge of markets, and commercial experience. Would consider any responsible position or representation.—Address, 6958, The Engineer Office. 6958 B

EXPERIENCED ENGINEER (35), 1st Class B.O.T., 3 years chief, 2 years Sudan, working knowledge Arabic, DESIRES POST, home or abroad.—Address, P1064, The Engineer Office. P1064 B

GOVT. ENGINEER (29), Public School, with Colonial Govt. over five years, carrying out variety heavy construction works and maintenance, steam and Diesel stations, &c. &c., as superintendent, well recommended, OPEN to OFFER suitable EMPLOYMENT abroad from established firm. Details on request.
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Address, P1045, The Engineer Office. P1045 B

MECHANICAL ENGINEER (29), Fully Qualified (G.M.I. Mech. E.), with experience testing, erection, maintenance of Diesel engines, marine and general manufacturing and repair work, works management and designing. Used to responsibility. Excellent references.—Address, P1048, The Engineer Office. P1048 B

OXY-ACETYLENE and ELECTRIC WELDER WANTS JOB; 12 years' experience, good worker.—S. COOK, 43, Towns End-place, St. Ippolyts, Hitchin, Herts. P1056 B

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Address, P1031, The Engineer Office. P1031 B

HEAT TREATMENT FOREMAN, with Extensive technical and practical experience of modern methods for heat treatment and welding of ferrous and non-ferrous metals, SEEKS POSITION.—Address, P1052, The Engineer Office. P1052 B

MISCELLANEOUS

BY an Agreement Dated 15th December, 1930, all RIGHTS and BENEFITS in connection with an INVENTION for Recording and Reproducing Sound (Patent Application No. 9992, of 1930) and all improvements in the said invention made by the inventor, were ASSIGNED by HARRY BENWELL STOCKS to ALFRED JAMES MUNRO and THEODORE DARCH PARKIN, both of 103, Cornwall-road, South Tottenham. P1057

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AGENCIES

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For continuation of For Sale Advertisements see page 68.

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The Metallurgist

"The Metallurgist" is a free supplement accompanying the last issue of "The Engineer" for each month.

It is devoted entirely to the science and practice of Metallurgy—ferrous and non-ferrous.

The following comments by a few of our readers indicate its usefulness in a field hitherto much neglected.

"The supplement is very well arranged and will be of considerable value to the Metallurgical Industry."—Sheffield, February, 1925.

"The advantages gained by the metallurgist and the engineer through closer contact is obvious and your supplement should aid in this...."—Washington, U.S.A., February, 1925.

"... Metallurgical Supplement is undoubtedly very good."—Manchester, January, 1926.

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"... the high standard of these supplements which falls into a No Man's Land Land between research workers and users...."—Birmingham January, 1927.

"... supplements which are of a high order and very interesting."—Newcastle, January, 1927

A Seven-Day Journal

The French Air Manœuvres.

EXTENSIVE air manœuvres were carried out for the first time in France last week, when an air attack was made upon the port of Toulon by squadrons numbering altogether 210 machines, drawn from Metz, Strasburg and the seaplane bases of Berre and Palivestre. The manœuvres were conducted in the presence of Monsieur J. L. Dumesnil, the Minister of Air, who recently returned from an inspection flight in French West Africa. The first operation was the bombardment of Toulon during the night, when, for two hours, 130 land machines passed over the arsenal, port and fortified places in successive waves. Each plane carried a load representing one ton of explosives. The weather was bad, and it is not known whether the squadrons fully attained their objective. The second operation was carried out with great secrecy by 120 land planes and 90 seaplanes. The attack began at 3 o'clock in the morning, but combined fog and rain compelled the machines to return. They started again seven hours later, when the weather had cleared a little, and the combined military and naval bombing squadrons, which were flanked by fighting machines, are declared to have partially succeeded in their task, notwithstanding the bad weather. The Minister of Air has stated that one result of the manœuvres is to show the necessity of increasing the weight of explosives carried by the machines.

Standards Association of Great Britain.

NOTICE was given last week that an extraordinary general meeting of the members of the British Engineering Standards Association will be held at the Institution of Civil Engineers, Great George-street, S.W. 1, on Tuesday, May 19th, 1931, at 12 o'clock. The business before the meeting will be formally to approve the proposed new title and by-laws, rendered necessary by the forthcoming changes in the organisation of the Association as set forth below. Copies of the proposed by-laws may be seen at the offices of the Association, but, in order to save the time of the members of the Association in different parts of the country, the Chambers of Commerce in the following towns have kindly agreed to place copies in their offices, for perusal by those members who may desire to see them :—Birmingham, Bradford, Cardiff, Derby, Glasgow, Leeds, Manchester, Newcastle, Nottingham, Sheffield. The Council has for some time past been considering the advisability of dropping the word "Engineering" from the title, and in conformity with the recommendations of the recent Imperial Conference, of reorganising the Association on a completely national basis, having four main divisions, Engineering, Chemical, Building and Textile, under a General Council, elected equally by these divisions. At its last meeting the Council definitely decided to recommend to an extraordinary general meeting of the members, that the new title of the Association should be the "Standards Association of Great Britain."

The Faraday Medal.

AT the meeting of the Institution of Electrical Engineers, held on Thursday, April 30th, when Professor W. L. Bragg delivered the Kelvin Lecture on "The Architecture of Solids," the Faraday Medal was presented by the President to Mr. Charles H. Merz, who has been responsible for many important electrical undertakings in this and other countries. His schemes include railway electrification in India, Australia, South Africa and South America, and he has, of course, been responsible for the design of many large power stations, both at home and abroad. He has been a member of Government committees dealing with electricity in mines, electric power supply, fuel economy, reconstruction, &c. From time to time he has read papers on power station design and electric power and traction problems before various Institutions, and it is probably correct to say that no other consulting engineer has rendered more useful service to the electrical industry.

The Government and Low-Temperature Carbonisation.

IN a statement made in the House of Commons on Tuesday afternoon last, May 5th, Mr. C. Edwards said that the Government had carefully reviewed the present position, and had decided that the low-temperature carbonisation of coal and the recovery of liquid fuels from coal could be effectively helped in two main directions. One of the first steps was to improve the value of tar oils, and in that connection the Fuel Research Station laboratory experiments on the production of motor spirit and Diesel oils would be carried further, by the development of the tests on a small commercial scale, which would cover the hydrogenation, cracking, and refining of tar oils. Plant costing about £33,500 would be put down and the staff and maintenance costs would be about £8000 per annum. The Department of Scientific and Industrial Research was also prepared to make grants for research on tar oils in the case of schemes submitted to it. The Government proposed to assist in bringing about a wider use of the smokeless fuel produced by low-temperature carbonisation processes by issuing instructions to Government Departments and through the Ministry of Health to local authorities to encourage the use of such fuel. Financial assistance would also be considered under certain conditions for public utility undertakings doing low-temperature carbonisation work. The developments in connection with the use of pulverised coal aboard ship had been carefully watched, and the research work on powdered coal at the Fuel Research Station would be continued, while the Government would consider, along with the shipping industry, what could be usefully done in order to extend the tests of various pulverised fuel systems which certain ship-owning firms had been carrying out under practical sea-going conditions.

The Reconstruction of the Royal Institution.

THE desirability of rebuilding a considerable part of the Royal Institution had long been recognised when, two years ago, it was decided that plans should be prepared for reconstructing the lecture theatre. This room had remained unaltered since the date—1802—at which it was completed under the supervision of Count Romford. Modern standards of security required that the theatre should be built of fireproof construction, and should be provided with sufficient exits. It had, also, to be suitable for scientific purposes. At the same time, the affectionate regard in which the old room was held by succeeding generations of members made it desirable to alter its appearance as little as possible. Advantage was, naturally, taken of the opportunity to bring the equipment up to date, and the theatre has now been provided with a cinematograph projector, an epidiascope, a number of services to the lecture table for experimental purposes, and other refinements. Among other parts of the building affected by the reconstruction of the theatre are the ante-room and the ambulatory. A new entrance hall, a new lecture laboratory and a new chemical laboratory have been built, and the basement area has been rearranged. The reconstruction work was carried out by Mr. L. Rome Guthrie, F.R.I.B.A., the architect to the Royal Institution, and Messrs. McLellan and Partners, of Victoria-street, acted as consulting engineers. The decorative work in the new parts of the building is in keeping with that of the older rooms, so that the air and charm of the old building have not been lost. The "house warming" of the reconditioned building took place on Wednesday last, May 6th.

The Aircraft Industry.

SPEAKING at the dinner of the Aeronautical Inspection Directorate last Friday night, May 1st, Lord Amulree said that it was very gratifying at a time of such depression in trade to find that the exports of the British aircraft industry were very much higher than five years ago. He gave the following figures for the value of aeroplanes, engines and spare parts exported during the last five years :—1926, £807,000; 1927, £845,000; 1928, £961,000; 1929, £1,558,000; 1930, £1,428,000. No less than 26 foreign countries, he said, were using aircraft or engines of British make. The figures included the value of exports to the Dominions and Colonies, but not those to India. He considered that although the Air Ministry was steadily increasing its orders for aircraft for the Royal Air Force, it was important, to secure continuity of employment, that firms should do their utmost to secure orders from abroad. British goods had always been famous for high standard of quality, sound construction and durability, and the fact that our aircraft so fully maintained that high tradition was mainly to be credited to the work of the Aeronautical Inspection Directorate during the last 18 years. In that period a system of inspection had been devised which, while leaving a high degree of responsibility upon the contractor, at the same time maintained a general high standard.

The New Southampton Graving Dock.

THE directors of the Southern Railway Company have placed with John Mowlem and Co., Ltd., of London, a contract for the construction at Millbrook, Southampton, of the world's largest graving dock. In order to expedite the work, the firm will carry out the operations with the assistance of Edward Nuttall and Co., Ltd., of Trafford Park, Manchester. The dock is to be ready to receive the new 73,000-ton Cunarder, which is now under construction in John Brown's Clydebank yard, and which, it is hoped, will be completed in the autumn of 1933. The leading officials have undertaken, unless unforeseen difficulties occur, to complete the construction of the dock within a period of two and a-half years. It will have a length of 1200ft. and a width of 135ft. at the entrance, with a depth of 45ft. over the tops of the blocks at high-water tides. It will be necessary to excavate to a depth of 87ft. below the quay level, and the operation will involve the lifting of over 1,000,000 cubic yards of material. In all probability, the excavation will be carried out by steam navvies in timbered trenches, but the details of procedure have yet to be settled. At the present time, the James Dredging, Towage and Transport Company, Ltd., is building an enclosing bank around the area in which the graving dock is to be constructed. This bank, it is held, will enable the work of excavating to be carried out with greater ease, as the mudland cut off from the river Test by the bank can be kept more or less dry by pumping. The value of the contract let for the building of the dock is over £1,000,000, and the whole scheme will involve an expenditure of about £1,850,000.

China's Iron and Steel Needs.

IN a communication from its Pekin correspondent our contemporary, the *Manchester Guardian*, states that plans have been submitted to the Chinese Government by the Minister of Industry for the establishment at Pukow, the railway terminus across the river from Nanking, of a great steel plant. A memorandum issued by the Ministry maintains that for the development of the industries of China production of iron and steel is essential. At present the country imports between 500,000 and 600,000 tons of iron and steel per annum, and owing to the great reconstruction plans that have been projected, the need for Government-owned smelting plant is held to be obvious. The iron ore reserves of the country have been established by an investigation conducted by experts, and it is believed that those of the Lower Yangtze Valley total 80,000,000 tons; this figure includes 4,000,000 tons at Feng Yuan Hill, not far from Nanking. According to the present plans, the production of the proposed steel plant will be 500 tons a day, so that, present indications being accepted, the ore deposits will suffice for China's needs for about 100 years. The plant will be served by a branch railway bringing coal supplies from Anhui and Kiangsu provinces. It is hoped that the whole undertaking, costing about £4,102,000, will be completed within three years, and that, reckoning from the present market price of steel, an annual profit of nearly £400,000 will be earned.

Associated Electrical Industries.

SPEAKING at the thirty-first annual general meeting of Associated Electrical Industries, Ltd., the chairman, Sir Felix J. C. Pole, explained that the profit for the year, including dividends from subsidiary companies, and after deduction of all expenses and charges other than interest on debenture stock and depreciation, amounted to £372,997, as against £365,961 for the preceding year. To that figure of £372,997 there had to be added the amount brought forward from last year, namely, £109,241, making a total of £482,238. Referring to the work done by the company, the chairman explained that, in spite of omnibus competition and the general impression that tramways were becoming obsolete, the volume of tramway business was greater than that for 1929–30. Developments had taken place in the design of tramway equipment, principally with a view to minimising noise and reducing maintenance costs. There had also been progress in the use of the trackless trolley omnibus, which would undoubtedly take the place of the tramcar where conditions were suitable. New induction motors produced during the year represented the latest and best practice in machines of that class. Silent motors for marine and other purposes had been developed in the acoustics section of the research department. Progress had been made in the art of arc welding, and various new processes were being developed for commercial application. There had also been some activity in connection with high-frequency furnaces for the special steel trades.

Professional Civil Servants.

IN his presidential speech at the annual general meeting of the Institution of Professional Civil Servants, held on April 30th, Sir Richard Redmayne stated that the very organisation of the Civil Service was of itself sufficient evidence of the contention that the status of the technical expert was unsatisfactory. Under the present organisation of the Service technical departments were overlaid by an administrative hierarchy which, by tradition and training, could not be expected to review administrative problems as problems requiring solution in the light of the requirements of a civilisation which had been revolutionised by scientific discoveries. One had only to look at the salary list for the heads of the professional, scientific, and technical departments and compare it with the remuneration obtaining on the administrative side of the service to realise that a great gulf was fixed between "administrators" and those who served the State by virtue of the possession of specialist knowledge. Sir Richard referred to the present chaos of multitudinous scientific and technical grades and stated that the Institution had advocated in its evidence to the Royal Commission on the Civil Service the formation of a much simplified graded technical service. The creation of such a service would bring home to the general public the underlying significance of the employment of experts, viz., that collectively they reflected the recognition and application by the community of the scientific discoveries which have altered the whole character of their daily life and were destined to effect even greater changes in civilisation if the country had the foresight and ability properly to utilise those discoveries to the common good.

The Cleaning of Power Station Waste Gases.

By JOHN B. C. KERSHAW, F.I.C.

ENGINEERS, in this and other countries, are devoting considerable time and energy at the present time to the investigation of the best methods of reducing the air pollution caused by boilers fired with pulverised fuel. The descriptions given below of the methods and apparatus in use in this country and on the Continent of Europe for cleaning the waste gases from power stations show that the problem is now being attacked in earnest, and in the course of the next two or three years one may expect some reliable figures of capital outlay and running costs per 1000 tons of coal consumed to be released for publication. For the present all engineers in charge of these experimental trials are very chary about publishing data of their operating costs. One can only assume, therefore, that they are high, and that they will have to be reduced considerably before these methods of cleaning and washing waste gases come into general use. The problem seems to have been solved technically, however, and what is now required is that it should be solved economically, and that a method and apparatus should be standardised which can be applied to all dust-fired boilers, whatever their size or steaming capacity, at a reasonable cost. As definition of a reasonable cost, the author gives the figure of 1s. per ton of coal consumed, this charge to cover both capital amortisation and running costs, including that for water.

THE PFLEIDERER SYSTEM.

The power plant at the works of the Badische Anilin und Soda Fabrik at Oppau, is one of the largest steam plants in existence. The original plant consisted of 44 boilers, producing low-pressure steam, and each capable of evaporating 60,000 lb. of water per hour. A large high-pressure boiler was installed in 1927. It has a heating surface of 21,500 square feet, and, with a capacity of 180,000 lb. of water per hour, is generating steam at a pressure of 630 lb. This new unit is fired with pulverised fuel by the Lopulco system, and the Pfleiderer method and apparatus for cleaning the gases is employed, in order to deal with the large amount of dust which passes from the furnaces to the short chimney stacks. Only a very restricted space was available when this boiler was erected, and it was decided, therefore, to adopt the double upright tube design for the boiler, with the economiser and air-heater superimposed upon it. This plan necessitated the erection of a boiler-house 130ft. high, and, on account of this great height, the chimney stacks only rise 20ft. above it.

The Pfleiderer system of cleaning the gases—see Fig. 1—is a combination of a cyclone type of grit and dust separator, with a gas washer of the sprinkler type, the two being operated together as one apparatus. The washer is mounted on the gas exit side of an induced draught fan, and the gases pass away directly from it into the short chimney stacks, as shown in the drawings. An efficiency of 90 per cent. is claimed for this system of gas cleaning.

A full-sized unit of the plant consists of two similar cylindrical chambers, 12ft. 6in. in diameter by 8ft. 6in. deep from the cover to the stop-valve, by which they are emptied. These chambers are constructed of boiler plate, and are placed directly behind the induced draught fans, which draw the gases from the economiser and air preheater, and pass them on to the chimney stacks. A system of water supply pipes is placed inside the cover of each of these chambers, the main pipes being 1in. to 1¼in. in diameter, and the branch pipes ending in nozzles of only 2 mm. diameter, spaced 80 mm. apart. The whole of the interior of the washer, and the baffle walls which divide it into numerous sections, are kept continually wet by aid of these water sprays. Each of the seven separate compartments into which the chamber is divided is provided with its own system of water pipes and sprays. The baffle plates are constructed of an alloy of lead and antimony in order to withstand the action of the dilute acid wash water, whilst, to protect the metal of the interior walls and plates, a lining of lead was used in the original design of washer. Later units, however, are lined with hard rubber, in place of lead, since that material not only protects the metal, but withstands better the abrasive action of the coarser particles of ash and grit in the cyclone portion of the washer. The last three compartments of the chamber are provided with vertical walls which split up the gas stream, and cause it to pass through very narrow concentric channels on its way to the chimney. These channels are provided with water sprays, as in the other sections of the apparatus, and it is in this portion of the washer that the very fine particles of ash, which are too light to be caught and removed by centrifugal forces, are brought into contact with the walls and are washed down by the water into the lower portion of the chamber. The mixture of water with grit, and fine ash, forms a slurry, which collects in the funnel-shaped bottom of the washer, and passes thence into a large separating tank, in which 80 per cent. of the solid matter is allowed to settle. The effluent from this tank, if it is to be employed again in the washing apparatus, requires filtration to prevent choking up the nozzles of the sprinklers. A washer of this type has been in use at Oppau for four years, and the results obtained in two separate tests, lasting 1 hour, are given in Table I.:—

TABLE I.—*Results of Tests with the Pfleiderer Washer at Oppau.*

Duration of test	1 hour	1 hour
Speed of waste gases in feet per second	66·9	66·9
Average volume of waste gases in cubic feet per hour—		
Before	6,742,300	6,742,300
After	4,906,700	5,012,600
Temperature of waste gases—		
Before	160° C.	160° C.
After	42° C.	49° C.
Wash water in gallons per hour	15,356	15,290
Recovered ash and grit in pounds per hour	4000	3571
Efficiency, per cent.	91·9	90·1

THE "MODAVE" SYSTEM.

This system of washing waste gases is employed in a large number of power plants in Belgium, France and Italy, but the largest installation is in this country, at Billingham, Durham—see Fig. 6. One of the largest steam generating plants in the United Kingdom has been erected there for the Synthetic Ammonia and Nitrate Works of Imperial Chemical Industries, and twenty washers of the Modave type have been installed in order to catch the dust from the boilers, which are all fired with pulverised fuel. The washer—see Fig. 2—consists of a series of rectangular tubes closed at one end, and placed vertically and at right angles to the path of the escaping gases. The water which is supplied from a tank placed above the installation, flows first into the interior of each tube, and then rises within it until it flows over the top. In this way a thin film of water passes continually down the outside of each rectangular tube, and as the elements of the washer are staggered, the dust-laden gases, on their path to the chimney, are brought into close contact with the water film which retains all the finer dust particles.

The washer is entirely automatic in action, and in order to maintain the required flow of water over the exterior of each element, it is only necessary to maintain a constant level in the supply tank, and to adjust the inlet and outlet valves of the washer, according to the amount of dust in the escaping gases. The water consumption of the standard type of washer, with six rows of elements, is stated to be 3 to 4 gallons per 1000 cubic feet of gas, and the temperature drop is approximately 125 deg. Fah. If the wash water can be re-circulated, only one-third of the above quantity is required, but if it is acid, some arrangement must be made for neutralising it. As regards efficiency, tests made at the electric power station at Auvelais, in Belgium, showed a dust recovery between 92 and 97 per cent., and an absorption of sulphur acids equivalent to 70 per cent. of the total amount present in the gas. Other figures for the efficiency of the Modave washer have been given by Rammler, for the installation at the power station at Issy-les-Molyneaux, near Paris. At this station 60 per cent. of the ash contained in the fuel was found in the gases passing to the chimneys, and the Modave installation has enabled 90 per cent. of this fine ash to be caught, before the gases are discharged.

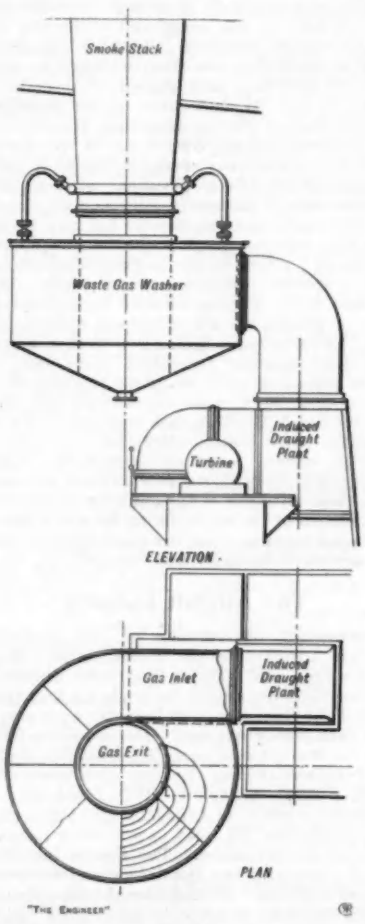


FIG. 1—PFLEIDERER GAS CLEANER

The following abstract from the authors' reply to the discussion upon the paper read by Messrs. Humphrey, Buist and Bansall upon the Billingham power plant last winter before the members of the London Institution of Electrical Engineers is of interest, since it explains why the Modave film type of washer was selected by the engineers in preference to any other for the Billingham steam plant. The full report of the paper upon the "Steam and Electric Power Plant at Billingham" and of the discussion upon it will be found in the *Journal* of the Institution, Vol. 68, pages 1233–1290, and in Vol. 69, pages 419–426. The dry system of separating the dust by cyclonic means was not adopted because the power requirements of this system are high, and also because the fine dust still remains suspended in the exit gases. The electrostatic system of precipitation was likewise put on one side because it required the flue gas velocity to be reduced to 3ft. per second, and the space required for installing it at Billingham would, therefore, have been prohibitive. The spray systems of washing were discarded, since there is a tendency towards choking of the ducts and chimney stacks, and this necessitates units being withdrawn temporarily from service. By the method of elimination, therefore, the moving film method of washing the gases was the only one left.

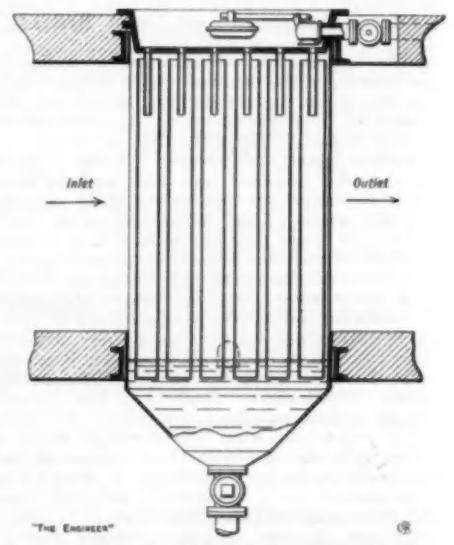


FIG. 2—THE MODAVE GAS WASHER

The three difficulties met with in applying it were the choking of the ducts, the erosion caused by the sand-blasting action of the dust particles, and the corrosion due to the acid nature of the wash water flowing from the apparatus. Choking has been overcome by the elimination of erratic sprays or drops of water; erosion has been overcome by employing low velocities, and corrosion has been overcome by using large quantities of the river Tees water, which is slightly alkaline. Very large quantities of this water are required—as much as three to four times the quantity of steam generated—but this is taken from the discharge side of the condensers of the condensing turbo-alternators, and, therefore, the cost of water for washing is not high.

Under the conditions obtaining at Billingham, it has been proved that the falling film method of gas washing is cheaper to install and operate than either the dry cyclone system or the electrostatic method. The actual efficiency of dust removal attained is 90 per cent., and in some cases is above this figure. The authors closed their reply by stating that painstaking research and heavy expense had been necessary to attain the desired ends at Billingham, but it was considered that the work was necessary from the point of view of the amenities and health of the district, and that the results achieved had some higher importance in relation to the huge generating stations of the future.

TABLE II.—*Details of the Boilers and Gas Washers at the Billingham Works of Imperial Chemical Industries.*

Steam Boilers—	
Number installed	8
Number working	5
Type of boiler	4 drum with water screens and water-cooled side walls
Capacity, pounds	98,000
Coal burned, tons	1280 per day
Working pressure, pounds	715
Steam generated, pounds	1,075,000 per hour
Normal evaporation per boiler, pounds	215,000 per hour.

N.B.—The total heating surface per boiler is 10,020 square

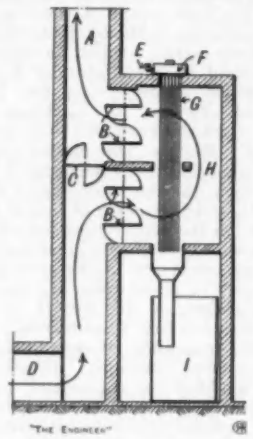
feet, of which 7640 square feet belongs to the boiler and 2360 to the water screens and walls.

Gas washers—

Number installed	20
Number working	10
Type of washer	Modave film
Gas volume, cubic feet per hour	5,130,000 up to 6,850,000
Gas velocity, feet per second	8 to 10
Water consumption, gallons per hour	325,000 up to 430,000
Efficiency, per cent.	90

The Pontaine de Bussy System.

The gas-cleaning system which is known under this name is one in which oil is employed in place of water for removing the finer particles of dust. The construction is shown diagrammatically by Fig. 3. Like the Modave washer, it has a series of



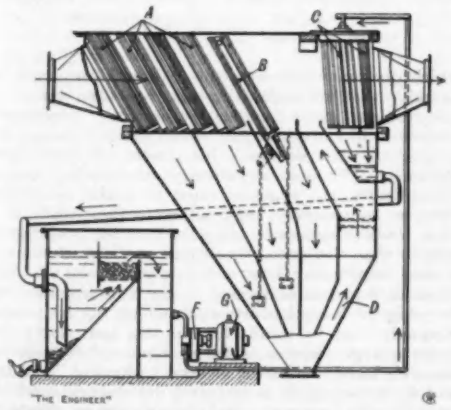
A, Chimney.
B, Revolving Dampers.
C, Exit Flue and Stop-damper.
D, Flue from Boilers.
E, Oil Supply Feed Pipe.
F, Oil Distributing Tank.
G, Bank of Separating Tubes.
H, Path of Gas through the Separator.
I, Collecting Tank for the Dust and Oil.

Fig. 3—Pontaine de Bussy System

vertical tubes over the external surfaces of which a thin film of oil is kept in movement by flow from a containing tank placed above the washer. The advantages claimed for oil in place of water are that it can be employed with waste gases up to a temperature of 350 deg. Cent. without any loss by evaporation. The mixture of oil and dust can be separated easily on standing, into two portions, one containing 99·7 per cent. of oil, and the other 64·3 per cent. of oil, and 35·7 of ash. By filtration the oil in this latter portion can be reduced to 25 per cent., whereas, if this mixture be passed through a centrifugal machine, it will still contain 40 to 45 per cent. of oil, and the recovery of the whole of the oil can only be achieved by the use of solvents and by distillation after separation of the ash. For these reasons, the use of bitumen or pitch has been suggested in place of oil for this apparatus, since the pitch can be recovered quite easily and economically for further use by first cooling the mixture, then crushing it, and finally extracting the ash and pitch mixture with hot water, when the ash will sink and the pitch will rise to the surface of the separating tank.

The Juwil Type of Washer.

This washer—Fig. 4— has been designed by Wilisch, of Wurzen, and consists of a combination of a dry



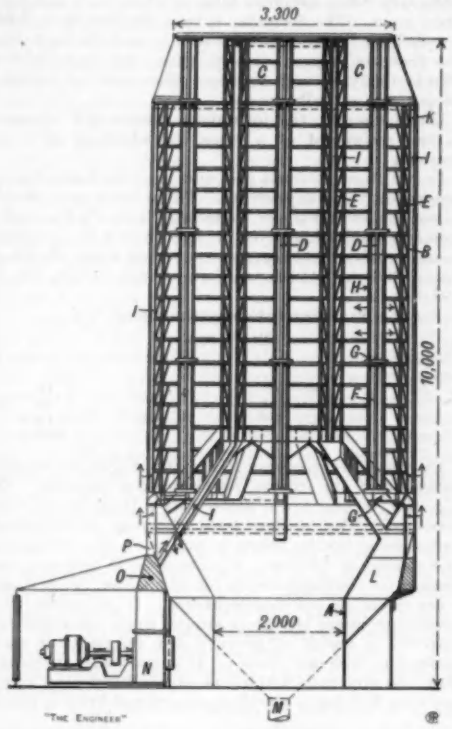
A, Division Framework of the Filter Portion of the Dry Separator.
B, Shaker Portion of the Dry Separator.
C, Walls Kept Moist by Capillary Action in the Wet Portion of the Separator.
D, Expansion Chamber between the Two Portions of the Separator.
F, Circulation Pump.
G, Motor for Driving the Pump and Shaking Apparatus.

Fig. 4—Juwil Washer

type of grit and dust separator using the bag filtration principle, with a wet film or dust catcher for the finer particles. The slurry from the wet portion of the washer on the right is carried to the separating tank shown on the left base of the diagram, in which the coarser particles separate by gravity, while the finer particles are caught in the filter bed through which the liquid is obliged to pass before it returns to the cycle of operations. If oil be employed with this type of apparatus, the methods of recovery adopted will be the same as those used with the de Bussy cleaner.

The Hildenbrand Separator.

The Hildenbrand dust separator—Fig. 5—is one of the latest German designs for the treatment of



A, Main Flue.
B, Tower.
C, Smoke-box.
D, Blowers.
E, Mixing Chamber.
F, Inlet Pipes.
G, Rings.
H, Outlet Slots.
I, Exit Flues.
K, Air Pressure Pipes.
L, Collecting Chamber for Grit and Dust.
M, Vent Pipe.
N, Blower.
O, Air Supply Pipe.
P, Connecting Channels.

Fig. 5—Hildenbrand Separator

waste gases from boiler plants burning dust or lignite fuel, and is in use at the Losse works in the town of Kessel, where the boilers consume brown coal obtained in the neighbourhood of the works, and also at the rolling mills of the Central German Steel Works, at Riesa, in Saxony.

The separator—see Fig. 5—consists of a tower, constructed on the columnar principle, in which the speed of the gases, as they pass from the main flue, is first reduced by one-half. This expansion is followed by a change in the direction of flow from vertical to tangential by means of air blasts supplied by rod-shaped blowers on air circulating pipes, carried up through the interior of the tower. The fine dust and ash, which are separated partly by centrifugal action and partly by gravity, are carried into the V-shaped collecting channels, shown in Fig. 5, and pass thence down into the dust collecting chamber L at the foot of the tower, and are then led for discharge to the vent pipe at M. No data have been published for the efficiency of this system of dust recovery from waste gases, but according to German engineering authorities the Hildenbrand tower is highly efficient for the dry separation of fine dust and grit,

Fig. 7—Hardinge Rovac Plant

and can be easily combined with a wet washer for separation of sulphur acids.

The Cleaning and Washing Plant at Derby.

The newest extension of the boiler plant at the works of the Derby Corporation Electricity Committee is provided with a Hardinge Rovac plant—see Fig. 7—for removing the dust and sulphur acids from the waste gases of the dust-fired boilers. It consists of a Hardinge thickener—seen on the lower left side of the illustration—for the slurry (14ft. in diameter), combined with a Rovac filter—seen on the platform—provided with a filtering surface of 75 square feet for recovering the fine dust and ash from the wash water. The recovery plant has a capacity of 5000 gallons of wash water and 4000 lb. of dry flue dust per hour, which is equivalent to 120,000 gallons of water and 96,000 lb. of flue dust per 24-hour day.

The flue gas before its discharge into the atmosphere, is obliged to pass through one or more screens of water produced by sprays which give a very high degree of atomisation. A whirling spray, a type of

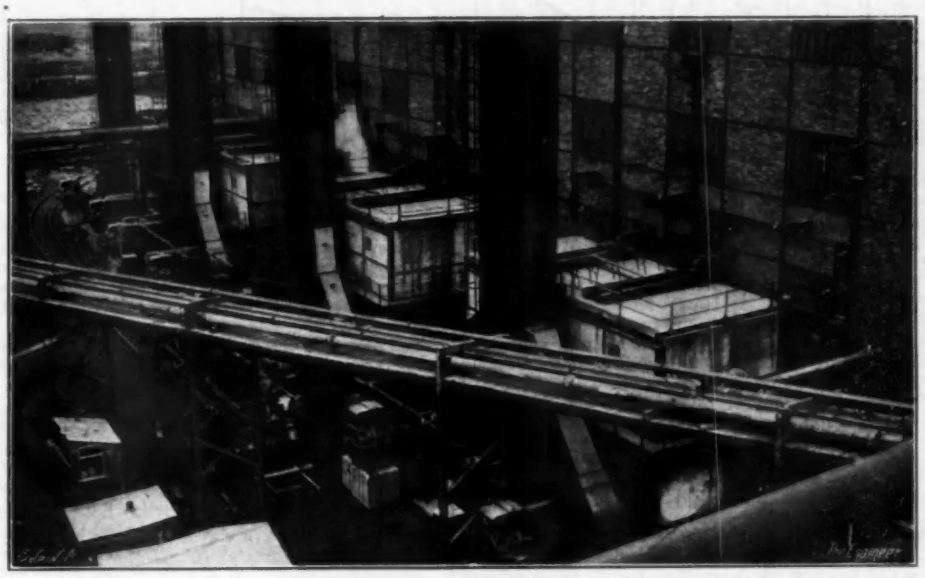


Fig. 6—Modave Gas Washers at Billingham, Durham

atomiser, has been found very effective for producing a mist of water, over the whole area of the flue, or chimney. The mixture of water and fine ash, or slurry, which is obtained in this way, falls by gravity into a sump at the base of the chimney. For a coal containing 15 per cent. of ash, from 3 to 4 tons of wash water are required per ton of coal consumed, provided that the heavier portion of the unburnt coke and grit has been already removed from the

waste gases by one of the dry centrifugal types of dust separator.

ASH REDUCTION BY MEANS OF SLAG CHAMBERS AND "SLAGGING."

With certain classes of fuel, which produce an easily fusible ash, it is possible to reduce the proportion of fine ash carried away with the chimney gases, by conserving the heat of the furnace, and by allowing the temperature of the combustion zone to rise sufficiently high to produce clinkering, or "slagging," of the ash. This can then be separated in the fused state, in what the Germans call a "Schmeltz-Kammer," or slag chamber, before the gases escape to the chimney. The Americans have been experimenting with this method of operating dust-fired boilers and have shown that from 30 to 60 per cent. of the ash can be retained in the furnace, when this system of operating the boilers is employed. At the Hell Gate power station, New York, the amount of ash retained in the furnaces has been increased further by combining the "slagging" method of furnace operation, with the plan of bringing the first bank of tubes as low down in the furnace as possible in order to intercept and catch the fused globules of ash. This method of working dust-fired furnaces at much higher temperatures is, of course, opposed to the plan which is now customary of keeping down the temperature of the furnace by enclosing it with water-cooled side walls. It is too early yet to say which system of operation is the best, but when fuels high in ash contents are being burned in the pulverised state it is probable that a combination of the slagging method with a dry dust extractor and a wet washer will be required in order fully to solve the dust problem of the large power stations situated in city areas.

Metallurgical Creep.

WE have received the following letter and memorandum and publish them with pleasure :—

SIR,—Imperial Chemical Industries, Ltd., have taken a great interest in the subject of creep stresses and have done much experimental work in this connection. One of my assistants, Mr. A. G. Hinton, has endeavoured to obtain a formula which more accurately expresses the relation between stress and log creep strain than those hitherto used.

He has been so successful that we cannot help feeling that his empirical formula must have a rational basis, and Mr. Hinton has made a suggestion which possibly expresses a fundamental relation. Anyway, at present we are unable to solve the riddle, and think that a useful purpose may be served by asking you to publish Mr. Hinton's report so that any of your readers who are expert in this subject may exercise their brains on the point.—Yours faithfully,

H. A. HUMPHREY,
Consulting Engineer to Imperial Chemical Industries, Ltd.

PROPOSED FORMULA CONNECTING RATE OF TENSILE CREEP AND STRESS.

When a series of tensile creep tests is made with varying stresses at constant temperature, and the curve is plotted showing stress as a function of log creep, one usually obtains a line which is nearly straight for a great part of the length, but which actually consists of a curve of double curvature.

For most practical purposes only the central part of the curve is required, and as this is nearly straight, a formula of the type $\log C = a + b\,p$ has hitherto usually been adopted, where C=creep rate, p=stress, a and b are constants. As this formula is only a rough approximation, a more accurate formula was sought, which would more closely represent the experimental facts and perhaps throw some light on the mechanism of plastic strain. After trying and rejecting various formulæ, the following was found to agree closely with the experimental results :—

$$C = k\,\frac{(p-a)^3}{(b-p)^3}$$

where C=creep (strain per unit time), p=tensile stress, k, a, b are constants which depend upon temperature.

This formula must, for the present, be regarded as an empirical one, though possibly a theoretical basis may be found for it. According to the formula, secondary creep becomes infinite when $p=b$ and zero when $p=a$. The formula, if true, implies that there is a definite limiting creep stress a, and the fact that the formula agrees closely with the experiments affords fairly strong evidence that such a limiting creep stress actually exists.

Dimensionally, the formula is correct if k is taken as the reciprocal of a quantity which is akin to viscosity.

In the above formula k, a, and b are constants which depend on the temperature. These have been determined for several steels, including Ni Cr, Cr Va, and a stainless steel (Charts 10, 11, and 12 of N.P.L. experiments), each at 300 deg. Cent., 400 deg. Cent., 500 deg. Cent., 600 deg. Cent., and duralumin (Chart 14) at 150 deg. Cent.

For the Ni Cr steel the constants are :—

Ni Cr Steel.

Temperature, deg. Cent.	k.	a.	b.
300	$3{\cdot}88\times10^{-6}$	23	44
400	$2{\cdot}46\times10^{-4}$	2	30
500	$1{\cdot}56\times10^{-3}$	0·5	14·5
600	$8{\cdot}1\times10^{-2}$	0	10

On the accompanying Fig. 1 the points are experimental and the curves represent the formula. On Fig. 2 k, a, and b are plotted as a function of temperature. The dotted lines showing extrapolated values must not be taken as authentic and are added as a matter of interest. At atmospheric temperatures there is no continued creep for any stress, hence a and b are equal at low temperatures. It is known that overstrain raises the proportional limit, provided the material is rested or given a low temperature heat treatment (200 deg. Cent.). It is probable, therefore, that—at any rate within the strain hardening range and over 200 deg.—a is the proportional limit *as raised* by the strain hardening which necessarily precedes the secondary creep. At low temperatures it is known that the proportional limit as raised by strain hardening and low temperature heat treatment coincides with the ultimate tensile stress ; hence the approach of curves a and b.

The shapes of the a and k curves indicate a critical temperature at about 360 deg. Cent. for this steel, probably corresponding to a structural change in the steel.

As regards a possible rational basis for the formula, it is known that steel gives by shear on slip planes, and that the number of these slip planes increases as the stress increases.* It may be that the creep on each slip plane varies as $p-a$ and that the number of slip planes per unit length varies as $\left(\frac{p-a}{b-p}\right)^2$.

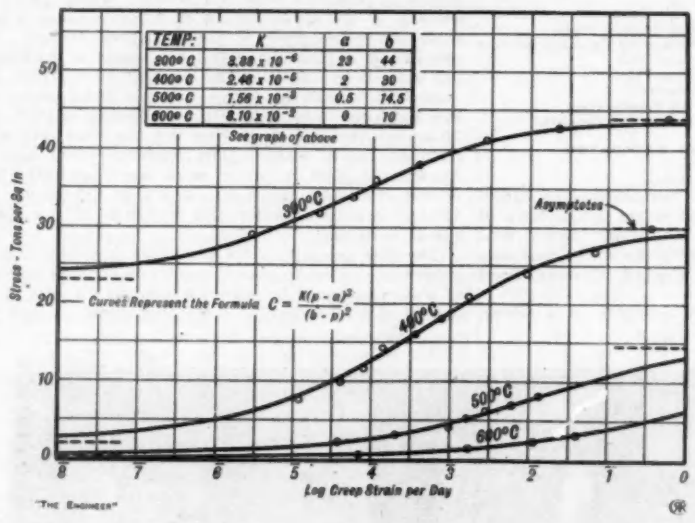

TEMP: K a b
300° C 3.88 x 10⁻⁶ 23 44
400° C 2.46 x 10⁻⁴ 2 30
500° C 1.56 x 10⁻³ 0.5 14.5
600° C 8.10 x 10⁻² 0 10
See graph of above
Stress - Tons per Sq In
Log Creep Strain per Day
Curves Represent the Formula C = K(p - a)³ / (b - p)²
300°C
400°C
500°C
600°C
Asymptotes
"THE ENGINEER"

FIG. 1

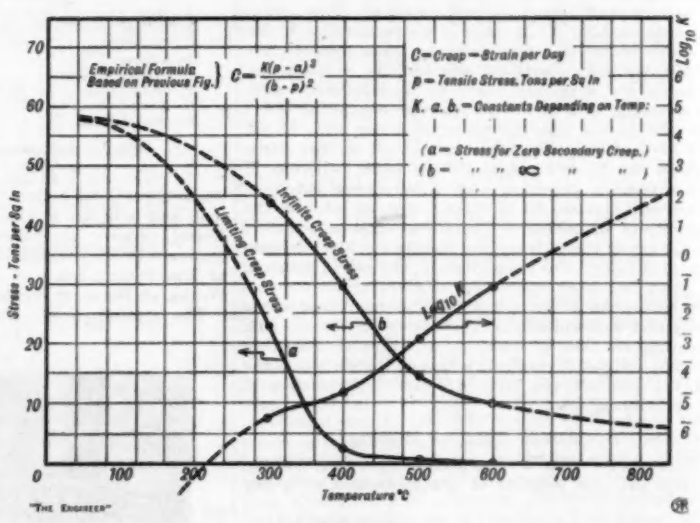

Empirical Formula Based on Previous Fig.) C = K(p - a)³ / (b - p)²
C = Creep = Strain per Day
p = Tensile Stress, Tons per Sq In
K, a, b = Constants Depending on Temp:
(a = Stress for Zero Secondary Creep.)
(b = " " ∞ " ")
Limiting Creep Stress
Infinite Creep Stress
Log10 K
a
b
Stress - Tons per Sq In
Temperature °C
Log10 K
"THE ENGINEER"

FIG. 2

ACCORDING to the report for the year ended March 31st, 1930, of the Indian Railway Board, there were during the year 812 miles of new railway opened, of which 326½ miles were of broad gauge, 412 of metre, and the remainder of 2ft. 6in. or 2ft. gauge. There were 93 miles of broad gauge, 116 of metre, and 19 miles of 2ft. 6in. gauge new line sanctioned, and at the end of the year there were under construction 731 miles of broad gauge, 457½ of metre, and 69 miles of 2ft. 6in. or 2ft.

* Seely in *Mechanical Engineering*, September, 1930.

Engineering Research.*

By SIR T. E. STANTON, C.B.E., D.Sc., F.R.S., M. Inst. C.E.

IN conferring upon me the honour of an invitation to deliver the James Forrest Lecture for 1931, it was the desire of your Council, I was informed, that I should deal with the work of engineering laboratories engaged upon the solution of engineering problems, and trace the progress and development which had taken place since the occasion when Sir Alexander Kennedy addressed you on the subject thirty-five years ago.

We must recognise in the first place that at that time almost all engineering laboratories were attached to educational establishments, and that the subjects studied were therefore, as far as possible, chosen so as to afford the best means of training engineering students in scientific methods of observation. This accounts to some extent, I think, for the fact that the matters discussed by Sir Alexander Kennedy were concerned almost entirely with the performance, economy, and efficiency of machines and prime movers, and of the plant required to supply them with motive power. Work of this nature was admirably adapted for satisfying the urgent educational need of that time, which was the equipping of the offices of engineers with a staff capable of taking the observations required for the performance tests of engineering works, which were becoming of great importance, and having a clear perception of the accuracy to which the results could be relied upon. In one of the most admirable passages of his lecture Sir Alexander Kennedy points out how fundamentally engineering problems differ from those of the physicist. "Engineering laboratories," he says, "are simply physical laboratories modified for engineering purposes, and the investigations in them are as much physical experiments as those in physical laboratories proper, but the two classes of experiment differ considerably, both as regards aim and scope, and the conditions under which they are made. Physical problems in general admit of one solution, and one only, and the physicist spares no pains to eliminate the most minute errors which will affect the accuracy of that solution. Engineering problems, on the other hand, are not in general capable of exact solution, and the engineer would be entirely wrong if he attempted more than a limited degree of accuracy." The carrying out of this kind of experiment requires a special faculty which does not come into the training of a physicist, namely, that of estimating the probable errors of observation made under engineering conditions, variations in materials, &c., which will tell the experimenter to what accuracy his conclusions will hold. He adds : "To treat a problem in engineering physics scientifically, the engineer must recognise its limitations as to accuracy, and not state the results in a form leading anyone to suppose that the accuracy is greater than the actual conditions of the work allow." I need hardly say that a full appreciation of these remarks is just as necessary to-day as it was then for the class of investigatory work which Sir Alexander Kennedy had in mind, but in the last thirty-five years a large number of the problems of engineering research have become of a more "physical" nature, and in consequence engineering laboratory methods have to some extent changed their character. Further, of course, we have to recognise that engineering laboratory research is becoming more and more detached from engineering education, and has for its object the solution of problems of industrial rather than of educational or philosophical interest.

[The lecturer then outlined the general activities of the Engineering Department of the National Physical Laboratory, and described briefly some of the problems which have recently been studied at the

* The Institution of Civil Engineers. The thirty-seventh James Forrest Lecture, May 5th, 1931.—Abstract.

Laboratory. He then devoted considerable attention to the important subject of scale model testing.]

To one who has been engaged in experimental work in engineering for the last forty years, one of the most striking developments which has taken place has been the increase in the application of the method of scale model testing to the solution of engineering problems.

The greater part of this development is due to the growth since 1910 of small-scale testing in aeronautical research, owing to the cost and risk of full-scale work; but, apart from this, the number of problems of a general engineering character for which a solution has been sought from a scale model test has been considerable in recent years.

Scale model testing is not, of course, a comparatively modern kind of test; in fact, the method was certainly foreshadowed in the thirty-second proposition of the second book of the Principia, in which Newton showed that two systems of particles, if started similarly, will continue to move in a similar manner, if the acceleration of each system is proportional to the product of the velocity and a linear dimension of the system, say, the diameter of a particle. This theory was extended by Stokes in 1850, and again by Helmholtz in 1873.

The first and perhaps the most important of all the practical applications of the method was that of William Froude in the development of experimental water tanks for the measurement of the resistance of ship models, and the prediction, from the results, of the resistance of ships.

The method was also applied to the engineering problem of the design of notches and weirs, to give a constant coefficient of discharge, by James Thomson in 1876.

It is to Osborne Reynolds that we owe some of the most fruitful applications of the method to engineering problems. Amongst these may be mentioned:—(1) The experimental demonstration of the conditions of similarity of flow of water in parallel channels (1888); (2) the theory of the sand blast, in which he showed that the stresses produced by the impact were independent of the actual size of the grains; and (3) the law of comparison in the formation of sand banks in tidal rivers and estuaries.

By these pioneers the foundations of the method were laid, and the last forty years has witnessed the continued growth of its applications to a wide range of problems.

Although I am a convinced believer in the value to the engineer of scale model tests, I do not propose in this lecture to put forward any plea for their recognition or arguments for their extension, as this has been done on several occasions in recent years in a more comprehensive manner than I could here attempt. On the other hand, as one who has been engaged in such tests for a great part of his life, and has a fairly intimate knowledge of the measure of success attained, I am inclined to think that what is wanted is a somewhat more critical review than has hitherto been attempted of the implications of the method, and of the extent to which the engineer may rely on the predictions to full-scale made from them.

I think that there can be no doubt that imperfect acquaintance with the necessary conditions to be satisfied in order that a true scale model test can be made has occasionally led to the performance of model tests which were not accurately to scale, and this has led to disappointment and loss of confidence in the method. In my experience I can recall one particular example of a very elaborate and costly scale model test in which the behaviour of the model was completely at variance with that of the full-scale phenomenon, for the reason that one of the most important conditions of similarity had been neglected. In some problems, also, there is the possibility that the performance of the full-scale phenomenon may deteriorate rapidly with time, and consequently exhibit results markedly different from those which it originally showed.

I propose therefore to make a few remarks on the principle involved in scale model testing, and then to discuss some of its applications. In the first place, it would, I think, be of advantage to define what is meant by a scale model test, since in this respect again the engineer and the physicist may not see eye to eye.

To the engineer a change of scale should be a more familiar process than to the physicist, as he is accustomed from his youth up to the production of what are called scale drawings of structures, in which he uses, as a measure of length, a strip of material divided in such a way that the actual distance occupied by one unit is a fixed proportion of 1ft.

With this scale he can set out on paper a representation of a structure such that the number of these units between any two points is identical with the number of feet between the corresponding points of the structure.

To the majority of engineers the statement "change of scale," means a change in the unit of length; but to the physicist this may mean, in addition, a change in the unit used for a measure of time and a change in the unit used for a measure of mass. The two cases are differentiated by saying that when the unit of length only is altered, the systems are geometrically similar, and when the other units are altered the systems are dynamically similar.

We may therefore define a scale model test in the most general sense as a test on a system, similar to that of the full-scale phenomenon, in which the units of length, time, and mass are each a definite proportion of the standard units in which the characteristics of the full-scale phenomenon are measured. For example, our new units may be one-hundredth of a foot, one-tenth of a second, and one-thousandth part of a unit of mass.

It seems to me that for engineers, to whom linear scale changes are so familiar, this method of looking at scale model testing has advantages which the classical method of treating the subject, by the principle of dimensional homogeneity due to the late Lord Rayleigh, does not possess.

As a writer on the subject has well said: "To the initiated, all the information obtainable from dimensional considerations is often evident upon mere inspection, so that any formal and detailed account of the reasoning appears greatly superfluous, and Lord Rayleigh's numerous applications are sometimes so cursorily described that the results seem rather like magic. But while a closer study of his solutions can only increase our admiration, it will certainly lead the average reader to wish for a less intuitive and more systematic procedure for obtaining the same results."

The question then arises whether any less intuitive procedure is available which would especially appeal to engineers. I think that such a method exists, and although it is somewhat laborious, this effect is counterbalanced by the benefit of obtaining clear ideas of what is done.

Adopting the representation of the scale model test in terms of the changed units as suggested above, general considerations show that complete similarity can only be obtained between model and full scale provided that units of length, time, and mass can be found such that the numbers expressing in these units the characteristics of the model system and of all the external forces brought to bear on it are identical with the corresponding numerical values expressing in the standard units the characteristics of the full-scale system and the external forces brought to bear on it.

This principle leads to a very simple relation which is that, when the characteristics of both systems and the external forces acting on them are all expressed in the standard units—say, feet, pounds, seconds—the ratio of the numbers expressing corresponding phenomena is in every case equal to the ratio of the appropriate units in which these phenomena are expressed.

This is, of course, obvious in the case of a scale drawing of a machine, since the ratio of any actual length of any element of the machine to the actual length on paper representing it is the scale ratio of the drawing.

The determination of the proper units of mass and time for the scale model test is a little more complicated, but in all cases we may say that if the ratio of the units of length, mass, and time used in the model test to the standard units be L, M, and T, then in our ordinary measure:—

$$\text{Velocity in model test} = \text{velocity on full scale} \times \frac{L}{T}.$$

$$\text{Force in model test} = \text{force on full scale} \times \frac{M\,L}{T^2}, \text{ \&c.}$$

The solution of the problem therefore follows at once from the observations in the model test, when once the values of the units have been found.

A practical example of the application of the method to William Froude's classical problem of the prediction of the resistance of a ship, from experiments on a scale model of it, will, I think, make the matter clear.

Suppose the ship is to be 640ft. in length and it is required to know the force to propel it through the water at 23·5 knots, say, 40ft. per second, against the pressure of the water on its hull and the frictional resistance of the water on its sides. By our rule, if a scale model test is possible by means of which the force can be determined, the units of length, mass and time must be such that the numbers expressing for the full-sized ship in water its length and velocity, the density of the water, the pressure of the water, the frictional resistance of the water, all in the ordinary units, must be identical with the corresponding numbers for the models expressed in the new units.

Assume in the first instance that the model test is to be made in water of the same density and viscosity as that in which the ship moves. For a scale model of the ship we can adopt any arbitrary unit of length, say, one-hundredth of a foot, and the condition of geometrical similarity can be satisfied and the model constructed.

Now take an arbitrary unit of mass, say one-thousandth of the unit mass—commonly called a slug—on the gravitational system. On the full scale and in the standard units the mass of unit volume of the water is $\frac{62\cdot4}{32\cdot2} = 1\cdot95$. Now we have fixed the unit volume of the water for the model test as a millionth of a cubic foot, and its mass in our ordinary units is therefore one-millionth of 1·95. In the new units where the unit mass is one-thousandth of a slug, the mass of this unit volume, or the density, will therefore be, not 1·95, as it should be according to our rule, but one-thousandth of 1·95; and we see at once, not only that the similarity condition is not satisfied, but that the only unit of mass which will satisfy it is one of one-millionth of a slug.

Now take an arbitrary unit of time, say, one-fifth of a second, and apply it to the acceleration of gravity to which the water pressure on the ship is due. This must be represented in both systems by the number 32·2. In the new units an increase in velocity of 32·2ft. per second is expressed by an increase in velocity of 3220 units of length per 5 units of time in 5 units of time, or 128·8; so evidently this unit is incorrect, and it is seen on inspection that one-tenth of a second is the correct one.

The units of mass, length and time are therefore fixed, and we notice at once that this has been done without reference to the friction of the water on the surface of the ship. Now this friction is in the main due to the viscosity of the water, the value of which, on our original assumption that the model test was to be made in water, should be the same for model as for full scale.

If, therefore, the numbers representing the viscosity of water in both systems of units are not identical a true scale model test under the conditions assumed becomes impossible.

Now the value of the kinematical viscosity of water at, say, 20 deg. Cent. in ordinary units is $^1/_{100000}$ foot^2/second units. In the new units one-hundredth of a foot and one-tenth of a second, it is easily seen that the number expressing it is $^1/_{100}$ (units of length)^2 per unit of time, so that our condition is again unsatisfied. We are therefore drawn to the conclusion that if the model test is to be made in water of the same density and viscosity as that in which the ship moves, the conditions of dynamical similarity cannot be satisfied—*i.e.*, a true scale model test is impossible. It is also easily seen from the above reasoning that if by any means one could add a fluid to the water in which the model test is made, such that its density would not be changed, but that its viscosity would be reduced one thousandfold, the conditions are satisfied and then the model test becomes possible.

As no means of reducing the viscosity of water to this enormous extent are known, we are compelled, following Froude, of course, to make a compromise and try to eliminate the friction effect from the problem. This is done by running the model test in water at the speed $40\,\frac{L}{T} = 4$ft. per second and subtracting from the observed resistance the calculated skin friction of the model. The result is the resistance of the model to the water wave system created by its motion, and this can be at once translated into forces on the ship due to water waves. Thus, if r be this corrected resistance of the model, the resistance of the ship to its own wave system will be $r\,\frac{M\,L}{T^2} = r \times 10^6$. A calculated value of the skin friction of the ship at 40ft. per second is then added, and the whole taken as the ship's resistance at 23·5 knots.

As those of you who are familiar with determinations of ship resistance are aware, this process is not an easy one, as there is no means of finding out the precise value of the skin friction of the wake on a ship's hull. The usual method is to take the value of the friction of thin plates towed in water and assume that this applies to the surface of a ship, but, as is well known, the friction of a ship-shaped form is not the same as that of a thin plate, owing to the formation of eddies at the stern, and corrections based on experience have to be applied, both to the observed result obtained from the model test and to the result predicted for the full-sized ship.

I have discussed this example of scale model testing at some length because it can be regarded as the classical case. There are others, however, which are of more direct interest to civil engineers, and to which I may draw your attention, such as the hydraulic resistance of pipe lines.

Since the discovery by Osborne Reynolds in 1889 of the effect of dimensions on the frictional resistance to the flow of fluids in pipes this subject has received considerable attention from research workers with scale models. From this point of view the conditions are simpler than in the case of ship resistance since it is friction alone we are concerned with, and any effects due to gravity can be treated separately with all the accuracy required. In giving an illustration of the method of making a scale model test of this type it would, I think, be of interest to consider the case when the fluid used for the model test is of different characteristics from the one in which the full-scale phenomenon takes place. For example, suppose it is required to determine the friction of a 6in. pipe conveying petroleum—whose viscosity is twice that of water, and density 80 per cent. of that of water—at 20ft. per second, and that for convenience we decide to make the model test with water flowing in a 2in. pipe.

The mass of unit volume of the fluid on full scale is $0\cdot8 \times 1\cdot95 = 1\cdot56$ slugs.

The mass of unit volume in the model test is $\frac{1\cdot95}{27}$ slugs.

Therefore if our new unit of mass is M slugs—

$$\frac{1}{M} \text{ of } \frac{1\cdot95}{27} = 1\cdot56, \text{ or } M = \frac{1}{21\cdot6} \text{ slugs.}$$

The kinematical viscosity of petroleum is 1/40000 square feet per second, and that of water is 1/100000 square foot per second.

Therefore if our new unit of kinematical viscosity is $\frac{L^2}{T}$

$$\frac{T}{L^2} \text{ of } \frac{1}{100000} = \frac{1}{40000}$$

or $$T = \frac{1}{3 \cdot 6} \text{ seconds.}$$

We can therefore at once write down the correct velocity of flow in the 2in. pipe for dynamical similarity of flow, which is $20 \frac{L}{T}$ or 24ft. per second, and having determined the skin friction per unit area of the pipe at this speed R, the skin friction of the 6in. pipe conveying petroleum at 20ft. per second will be $R \times \frac{39}{21 \cdot 6}$. It will be noticed that in the above test a considerable reduction in the speed at which the model test is carried out was effected by using fluid for the model test of less viscosity and greater density than that used on full scale. For example, if the model test described above had been made with petroleum instead of water, the speed of flow on the model test would have been 60ft. per second. This condition is not of great importance in hydraulic research, but in the determination of the characteristics and resistance of aircraft from scale models of them or their components, the difference in linear scale of model and airship or aeroplane is necessarily so great, on account of the limited dimensions of the wind tunnel in which the model tests are carried out, that the similarity conditions cannot in general be carried out without introducing another variable in the form of compressibility.

For this reason attempts are now being made to carry out model tests in wind tunnels supplied with compressed air. In the tunnel now under construction at the National Physical Laboratory, the working fluid for the model tests will be air at a pressure of 25 atmospheres, which will make possible a very large increase in the range of scale model experiments for aircraft.*

In the prediction of hydraulic resistance from scale model tests which I have described there is one possible source of error, which is not always appreciated. Since strict geometrical similarity is required between model and full scale, this should, of course, apply to the irregularities in the surface which constitute roughness. In ordinary engineering work this is an extremely difficult and almost impossible condition to satisfy, and if the influence of surface were found to extend to surfaces very much smoother than those having ordinary commercial finish, the results of scale model testing applied to problems of pipe flow would not be very reliable. Fortunately, it has been found that carrying on the smoothing process to a degree beyond that obtained in commercial finish does not reduce the friction—that is to say, in the case of two pipes of, say, 1in. and 5in. in diameter, in which the surfaces are of the same degree of smoothness, tests with the same fluid at the same value of V D, which is the similarity condition, give the same value of the resistance coefficient. For pipes in which the roughness exceeds commercial finish the effect is considerable, and it is quite common to find an increase in frictional resistance of 50 per cent. due to this cause.

While on the subject of pipe flow, I may perhaps be allowed to refer to the well-known general case of flow of fluids in pipes which has received so much attention at the National Physical Laboratory. The result of these researches, as was to be expected from dimensional considerations, showed that the frictional resistance to flow of all fluids, such as air, water, and heavy oils, can be represented by one curve, which gives the value of the coefficient of resistance for any particular value of the product of velocity and diameter of pipe divided by the kinematical viscosity of the fluid.

I have frequently come across cases in which this relation has been applied indiscriminately to practical problems, and occasionally with disappointing results, owing to the fact that the conditions for which the relation holds have not been appreciated. Of these, I have already mentioned the case of surface roughness. Other conditions are that the portion of pipe to which the relation applies must be (1) straight and (2) at least 50 diameters from the inlet, so that all accelerations have died down. It is clear, therefore, that the relation may not apply to cases in which the pressure head required to set up the velocity or part of it is also included in the total; and also that the resistance of pipe lines containing a fair proportion of bends and elbows may differ from the resistance of a straight portion of the same length.

As an example of the relatively large effect of sudden changes in the direction of motion of fluids in pipes, I may quote an experiment recently carried out at the National Physical Laboratory in which the frictional resistance of two 6ft. lengths of ½in. piping conveying air was determined. One of these was straight and the other had eight elbows. The head required to maintain the flow in the latter was found to be 230 per cent. greater than that required for the straight length, which means that the loss of head in causing a sudden change in direction of the fluid of 90 deg. is equivalent to the frictional loss on a straight length of nearly 50 diameters.

Another interesting example of scale model testing is the prediction of the wind resistance of roofs and bridges. The similarity conditions to be fulfilled in order that the forces on the scale model of a roof or bridge may be used as design data for the full-sized structures are the same as those applying to hydraulic systems, since the viscosity and density of the air are the only external forces to be considered; but, in the case of roofs and bridges, the distribution of the velocity of the air is of such extraordinary complexity that it is almost hopeless to try and set up a scale model of the motion. This complexity is due partly to the variation in the wind's velocity with distance from the ground, which differs greatly according to the locality of the site, and partly to the eddies set up by surrounding buildings and irregularities on the surface of the ground. These conditions render the problem of a scale model test on roofs and bridges a much more difficult one than the determination of the forces on aircraft, which are generally supposed to be under the action of a uniform wind. While, therefore, a test on a scale model of an aircraft exposed to the uniform current of air in an ordinary wind tunnel may be expected to furnish reliable results, implicit reliance for design purposes on the forces experienced by a scale model of a roof or bridge under such conditions might lead to serious error.

The roof problem is, perhaps, the more complicated of the two for the following reasons. Measurements of the distribution of pressure over the surface of buildings with inclined roofs in a wind have shown that by far the most severe stressing may be caused by the force tending to lift the lee side of the roof. This force, it should be realised, is the sum of two distinct effects: (i) the reduction of pressure on the outside of the roof, relative to the static pressure of the atmosphere, due to the wind eddy from the ridge; and (ii) the augmentation of the pressure inside the building above this static pressure due to the dynamic action of the wind, and if the full dynamic head of the wind is produced inside the building by doors and windows being open to windward the resultant may be large.

A striking demonstration of this effect was exhibited in the case of the London County Council houses at Becontree during the very violent gale which occurred during the night of November 16th and 17th, 1928. In this gale five or six thousand roofs were slightly damaged, and in 80 per cent. of these a patch of seven or eight tiles was lifted from the lee side of the roof at a point approximately 3ft. away from the end face of a chimney stack and 6ft. to 8ft. below the ridge level.

At the request of our President, Sir George Humphreys, who placed two houses at Becontree at our disposal, we erected apparatus by means of which the pressure difference between the inside and outside of the roof could be measured. The possibility of a gale of the same intensity and blowing from the same direction springing up in the time at our disposal was, of course, very remote, but our observations did establish the importance of the effect of the dynamic head inside the building, as was shown by the fact that when the inside surface of the roof was protected by matchboarding so that the momentary dynamic pressure inside the building and acting outwards due to the gust was eliminated, the lifting force on the tiles was only from one-third to one-fourth of its value without this protection.

In the bridge problem, on the other hand, an important consideration in design for wind stresses is the possibility of a lateral variation in the velocity of the wind over the bridge such that the effect of a gust of wind on the whole span is much less than that due to the maximum wind velocity at any point in its area. In a paper which I had the honour of reading before the Institution in 1924, on experiments on the Tower Bridge, I brought forward evidence indicating that an appreciable reduction in the value of the wind pressure factor due to this cause could not always be relied upon for spans up to 300ft. in length. The experiments now being carried out at the Severn Bridge at Sharpness by Mr. A. Bailey, of the National Physical Laboratory, over a span of half a mile, by means of an electrical wind pressure recorder which he has devised for the purpose, will determine whether the same conclusion applies to bridges of large spans, and will also solve, it is hoped, other interesting problems of wind structure.

* The construction of this tunnel was described in our issues of April 17th and 24th.—ED. THE E.

Reorganisation of the Iron and Steel Industry.

THE following memorandum was issued recently by the National Federation of Iron and Steel Manufacturers.

It is not surprising that the prolonged depression in the iron and steel industry is causing the Government grave concern, but recent speeches by the Prime Minister and the President of the Board of Trade are calculated to give the public the impression that the industry itself is doing nothing to improve the position. In order that the constant repetition of charges of inefficiency, if not unrefuted, may not come to be believed by those who have no means of knowing the truth, it is, perhaps, advisable to recapitulate some of the measures which the industry has taken to improve its position in spite of very severe handicaps. It should be obvious that those engaged in the industry, both employers and employed, are more gravely concerned with its present continued decline than any of its critics, political or other, and, therefore, may confidently be expected, as, indeed, is the case, to make the strongest possible effort which their knowledge and experience suggests to survive the continuance of present conditions.

The industry has demonstrated to more than one Government that its wages, taxation, social charges, transport costs, capital charges, and so on, are much heavier than those of its competitors abroad—wages in France, Belgium, Luxemburg and Czecho-Slovakia, for instance, are less than half of ours—but Mr. Graham tacitly ignores these handicaps and claims to believe that a drastic reorganisation is alone sufficient to rehabilitate the industry, but reorganisation requires capital which is only available when confidence is established; present conditions have destroyed confidence. He also believes that if a tariff were given it would delay this process of reorganisation, although he does not explain how it is that those industries which, by implication, are so much more efficient than ours, are situated in protectionist countries. But while the industry claims that many of its difficulties are due to political, financial and economic policies over which it has no control, it has not, on that account, refrained from making increasing and most strenuous efforts to survive. Under the ægis of the National Federation of Iron and Steel Manufacturers, an "Iron and Steel Industrial Research Council" has been formed with a view to promoting production economies. Some of the keenest intellects in the world of science, as well as in the industry, are grappling with these problems and great progress is being made. Progress is also being made with the regional reorganisation of which Mr. Graham spoke. In Scotland, for instance, the steel interests of Messrs. Colvilles, Beardmore and Dunlop have already been combined and production concentrated at Messrs. Colvilles' works, while an even more comprehensive scheme for that area is under consideration. On the North-East Coast, the amalgamation of Messrs. Dorman Long and Co.—which had previously incorporated Messrs. Bell Bros. Carlton Iron Company, Sir B. Samuelson and Co., and other works—and Bolckow-Vaughan, took place in 1929, and negotiations for closer working arrangements with other North-East interests are proceeding. In the Midland area, the United Steel Companies comprise the Sheffield firms of Steel, Peech and Tozer, Samuel Fox, Daniel Doncaster, United Strip and Bar Mill, the Workington Iron and Steel Company on the West Coast, and the Frodingham and Appleby Iron and Steel Companies in Lincolnshire, while the most recent amalgamation in the Sheffield area is that of Messrs. John Brown and Thos. Firth and Sons, which, it is understood, is preparatory to closer working with the English Steel Corporation, which is itself a comparatively recent amalgamation of the heavy steel departments of Vickers Armstrongs and Cammell Laird. In Lancashire, the Lancashire Steel Corporation has been formed by the amalgamation of the iron and steel departments of the Partington Iron and Steel Company, Pearson and Knowles, Ltd., and the Wigan Coal and Iron Company. In South Wales, the heavy steel interests of Messrs. Baldwins and Messrs. Guest, Keen and Nettlefolds have amalgamated and formed the new firm of the British (Guest, Keen, Baldwins) Iron and Steel Company, Ltd., while in the tin-plate trade Messrs. Richard Thomas controls about 50 per cent. of the trade. This list is by no means exhaustive, but sufficient examples have been given to show that the industry is fully alive to the advantages of large-scale production.

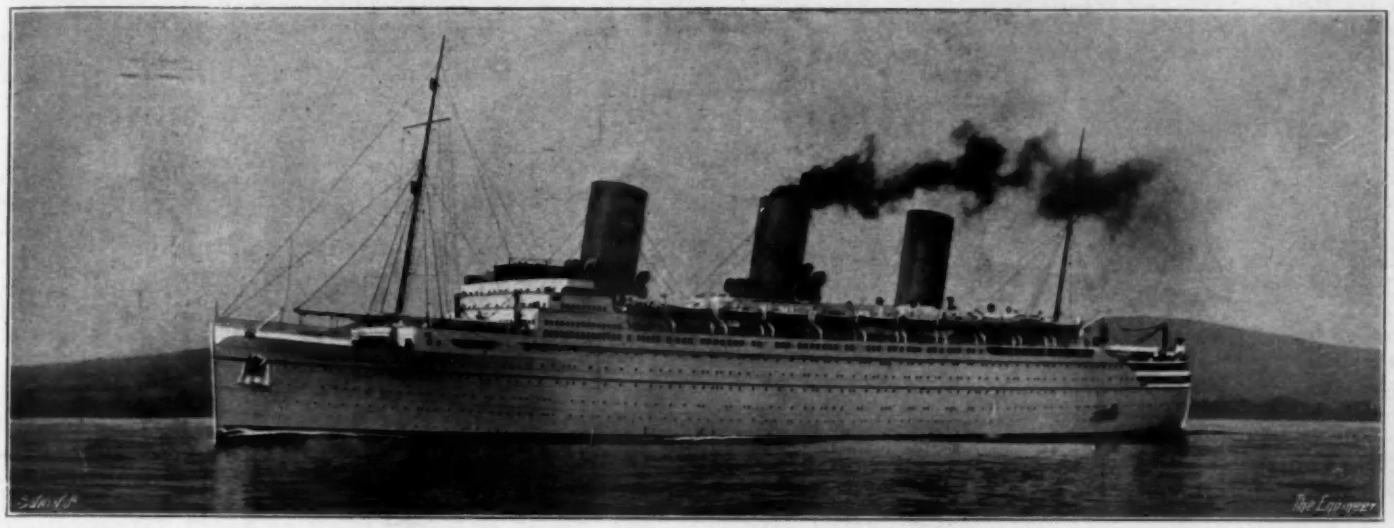
Apart from the amalgamation of firms, co-operation has proceeded for the promotion of the export trade by the formation of the British Steel Export Association, which comprises *all* the makers of plates and sections—that is, shipbuilding and structural material. The Association, in its present form, dates from October 1st, 1929, and is an extension of a previous scheme dated July, 1928. Even before that date makers often combined to capture substantial orders in the face of fierce continental competition. The British Steelwork Association is very active in its propaganda for the increased use of British steel, and it has also promoted research into the building regulations with a view to making possible the increased use of steel for structural purposes.

Not only is the policy of co-operation being actively applied at home; it has also been adopted in our relations with the Dominions, the latest evidence of which was the extension of the constitution of the Federation at the beginning of this year to render iron and steel industries in the various Dominions eligible for membership of the British Federation. There is no need to enter into great detail regarding the efforts of the steel makers to increase the employment capacity of their industry, but perhaps enough has been said to show that there is no excuse for a repetition of the statements that the industry is not exerting itself to the utmost with the very slender resources which present economic conditions render possible. The industry has, for the past ten years, been fighting a rearguard action for survival under conditions imposed upon it by national, political and financial policies which, to any informed and unprejudiced observer, constitute overwhelming odds. It will continue the struggle in the confident belief that, quite irrespective of politics, the Government of this, the most highly industrialised country in the world, will be compelled by economic necessity to adopt a policy designed to restore prosperity to industry and employment to our people.

SPEAKING at a recent meeting of the Rubber Growers' Association, Mr. W. Shakspeare said that rubber paving blocks capable of standing up to the most intensive traffic were being marketed at a cost in the region of 50s. per square yard, with a free maintenance guarantee extending over a period of 10 years, and beyond that period maintenance should be negligible. A reasonable calculation of the cost to a borough authority of wood-paving over a life of 15 years worked out at 45s. per square yard, and as a much longer life was claimed for rubber the ultimate advantage would appear to be in favour of the latter commodity on the ground of cost, quite apart from the unique advantage of rubber as a shock-absorbing material.

THE QUADRUPLE-SCREW CANADIAN PACIFIC LINER "EMPRESS OF BRITAIN"

JOHN BROWN AND CO., LTD., CLYDEBANK, BUILDERS AND ENGINEERS



The Machinery of the C.P.R. Liner Empress of Britain.

No. I.

INTRODUCTION.

THE new Canadian Pacific liner "Empress of Britain," which, on Wednesday, May 27th, is scheduled to sail from Southampton *vid* Cherbourg and Belle Isle Straits on her maiden voyage to Quebec and Montreal, is without doubt the most important and interesting ship of the present year. Her advent on the Canadian Pacific Railway Company's North Atlantic service will bring recognition of the great advantages of the Canadian route for all Atlantic passengers who require to travel to or from west of Chicago. She has a normal service speed of over 24 knots, which will permit her to make the open sea passage in about three and a-half days with one and a-half days on the St. Lawrence River, during which period all Customs and immigration formalities will be completed, allowing passengers to proceed immediately to their destinations. The total distance between Cherbourg and Quebec *vid* Belle Isle and Cape Race is 2740 miles and 2520 miles respectively, as against 3160 miles from Cherbourg to New York. Thus a reduction in the distance travelled which, taking into account the speed of modern liners, means a saving of at least ten hours is effected.

The "Empress of Britain" bears the distinction of being the second largest liner to be built by John Brown and Co., Ltd., on the Clyde, while she is also the largest British liner plying between Empire ports. To meet the special services for which she was designed a quadruple-screw arrangement of geared turbines, operating with high-pressure steam, has been adopted, with a total normal output of 63,000 S.H.P., divided between the inboard and the outboard screws in the ratio of two-thirds to one-third. The turbines and boilers are arranged in the forward and aft machinery spaces, as shown in our drawing. Astern power equal to 80 per cent. of the ahead power is provided by the inboard turbines, which are alone used for manœuvring operations. The choice of a working steam pressure of 425 lb. per square inch with an initial steam temperature of 725 deg. Fah. is a consecutive step in the application by Mr. John Johnson, the company's chief superintendent engineer, of the most modern high-pressure steam practice to the vessels of the company's fleet. In the re-engined "Empress of Australia" a fuel consumption for all purposes of 0·71 lb. with oil fuel Scotch boilers was, it will be recalled, obtained, which figure was shortly followed by one of 0·625 lb. in the "Duchess" class liners, and later by 0·603 lb. in the Fairfield-built liner "Empress of Japan." On the recent trials of the "Empress of Britain," which occupied over seven days, during which the ship was loaded to her mean ocean displacement and with all hotel services in operation, a figure of 0·57 lb. of oil per S.H.P. hour for all purposes was obtained on the twelve-hour endurance trial, which is a world record performance. On the Arran measured mile a maximum speed of 25·52 knots with the four sets of turbines in operation was reached, while a speed of 22·6 knots under cruising conditions was recorded with only the two inboard turbines working. An interesting fact is that the propulsive coefficient and thermal efficiency of the installation under cruising conditions was shown to be slightly higher than when working with four screws. Under all conditions of operation there was a pleasing absence of vibration. Special trials were carried out with the "Johnson" water-tube boiler unit, which bore out conclusively, we understand, the claims made for this new type of steam generating plant.

In what follows we deal briefly with the general design of the hull and passenger accommodation and pass on to some special features of engineering interest.

GENERAL DESIGN.

Some idea of the pleasing appearance of the liner will be gathered from the view reproduced above. The vessel has been constructed under Lloyd's Register Survey to the highest 100 A1 class with a freeboard corresponding to the full draught of 32ft. In addition, the requirements of the Board of Trade and the International Convention for Safety of Life at Sea have been fully met both as regards the water-tight subdivision of the ship and the provision of life-saving facilities and up-to-date navigational appliances. The new liner has a straight stem, raking well forward, and a cruiser stern, an excellent view of which is given in Fig. 2, which is reproduced from a photograph taken at Clydebank shortly before her launch. The lines of the ship were determined after careful model tests and experiments had been carried out by Mr. G. S. Baker, of the National Froude Tank at Teddington, and by the builders at Clydebank. She has two masts, with fore-and-aft rigging, which measure 208ft. above the loaded water line and are the largest yet constructed at Clydebank. The funnels are three in number and are pear-shaped, having a fore-and-aft length of 35ft. at the top, with a maximum width of 27ft. They are carried to a height of 68ft. above the top sun deck, and it is of interest to learn that during the recent official trials it was found that under all conditions of steaming and changes of wind and weather the deck spaces which have been provided for

FIG. 1—THE RUDDER STOCK AND RUDDER FRAME

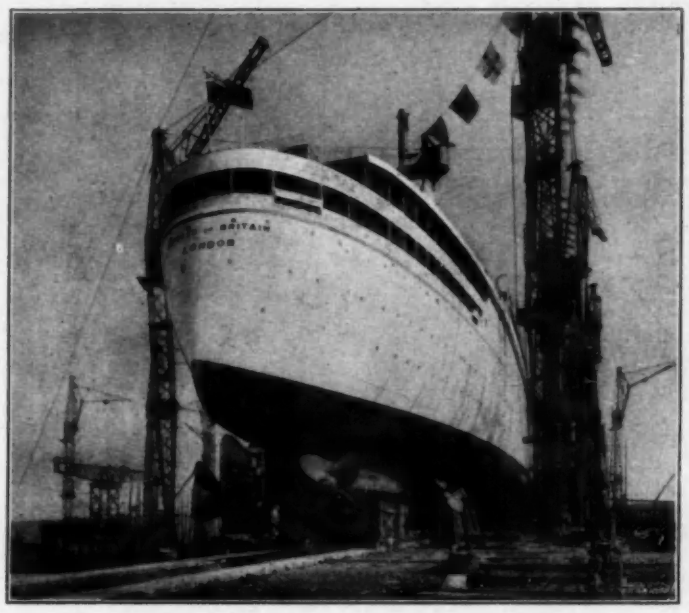
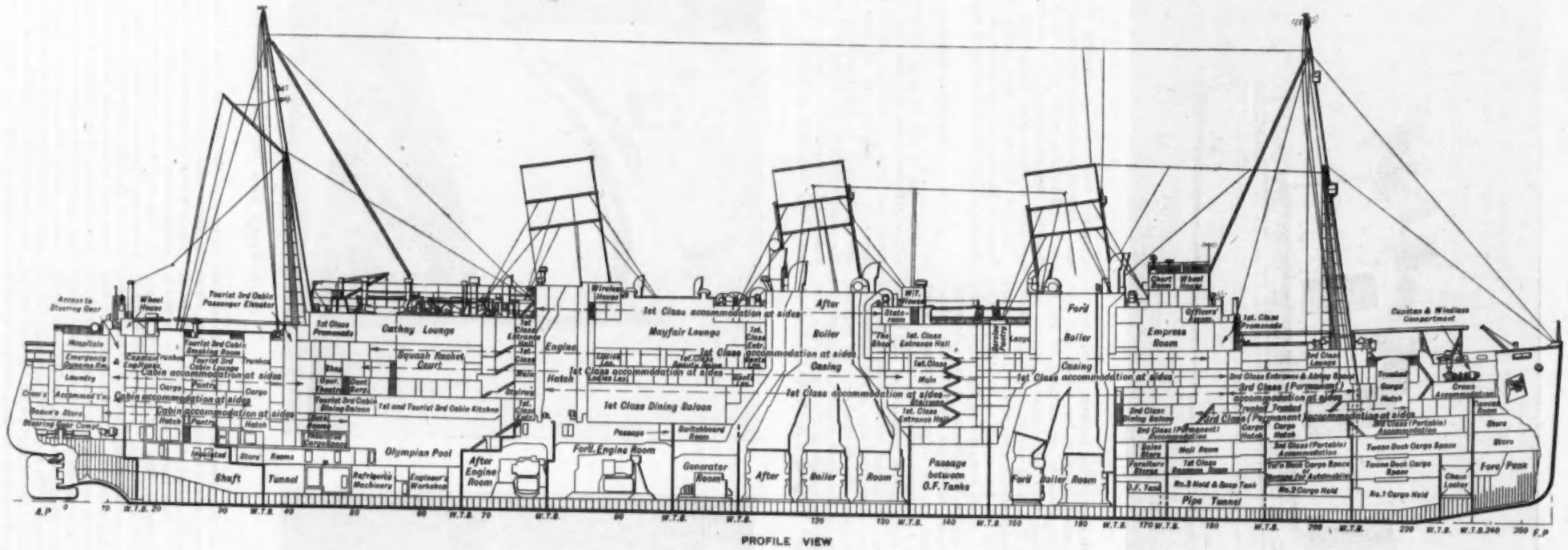


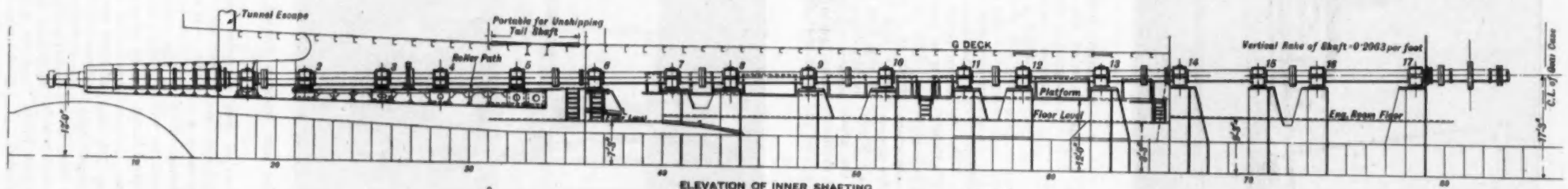
FIG. 2—STERN VIEW BEFORE LAUNCHING

THE 42,300 GROSS TON QUADRUPLE-SCREW CANADIAN PACIFIC LINER "EMPRESS OF BRITAIN"

JOHN BROWN AND CO., LTD., CLYDEBANK, BUILDERS AND ENGINEERS

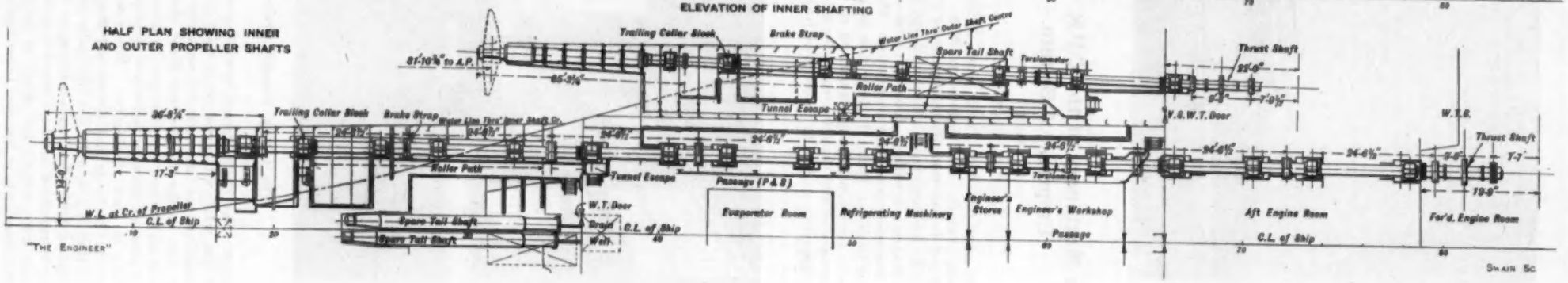


PROFILE VIEW



ELEVATION OF INNER SHAFTING

HALF PLAN SHOWING INNER AND OUTER PROPELLER SHAFTS



"THE ENGINEER"

SHAIN Sc

outdoor recreation were at all times immune from smoke and funnel gases.

The principal dimensions of the ship and other particulars are given in the table below :—

Length overall	760ft. 6in.
Length between perpendiculars	730ft.
Breadth moulded	97ft. 6in.
Depth moulded to "B" deck	60ft. 9in.
Depth moulded to top of superstructure (sun deck)	100ft. 6in.
Loaded draught	32ft.
Gross tonnage	42,348
Net tonnage	22,545
Normal service speed	24 knots
Designed service horse-power	63,000 S.H.P.

Passenger Accommodation.

First-class passengers	465
Second-class passengers	260
Third-class passengers	470
Officers and crew	714
Total number of persons carried	1909

The general arrangement of the decks may be gathered from the profile view of the ship reproduced opposite. They are ten in number and, from the top downwards, are the sun deck, sports deck, and lounge or promenade deck, below which they are lettered A to G, decks F and G only extending fore and aft of the machinery spaces. The longest deck is A, which runs the full length of the ship. Above it is the lounge deck, with a length of 648ft., which is closed at the end by a steel screen carried across the front of the ship and extended for a distance of 340ft. along each side of the lounge deck. This screen is furnished with large rectangular windows. For the greater part of its length the lounge deck has a width of 18ft. each side, while on the sports deck above a long promenade space is available beneath the boats, and forward amidships on the same deck there is a large space suitable for games. The sports deck has a length of 396ft. at the sides, while at its centre, in the way of the first-class public rooms, a raised deck extends for 455ft. at a height of 14ft. above the lounge deck. The top or sun deck, which has upon it some casings and deck-houses, is 192ft. in length. In all, the deck spaces of the ship are particularly noteworthy, as they are unsurpassed on any other liner of the same size.

The subdivision of the hull is effected by fourteen water-tight bulkheads, which are indicated in our profile drawing, and throughout the ship water-tight doors working on the Brunton hydraulic principle and controlled from the bridge are fitted. The double bottom is carried well up the bilges, and extends all fore and aft. It is divided into forty-four main compartments for the carriage of oil fuel, fresh water, and ballast water, while in the way of the forward and aft engine-rooms it is carried up as an inner skin to the underside of E deck, the compartments so formed being arranged as fresh water tanks.

In determining the scantlings of the hull the vessel was treated as a structure of the continuous girder type to the sun deck, thus enabling the use of expansion joints to be obviated. For some of the deck and side plating in the upper part of the ship a high elastic limit steel was employed, and effected a valuable reduction in top weight. The main frames are spaced at intervals of 39in. amidships, reduced to 24in. in the after peak, and 18in. in the fore peak. The frames in the way of the oil bunkers are of 10in. deep channel section, a depth of 12in. being used for the frames, which are fore and aft of the bunkers. All the beams for the decks are also of channel section, and are supported by four rows of tubular pillars attached to continuous channel girders. For the dining saloon and the ball room large spaces entirely free from pillars have been provided. In the case of the dining saloon an area of 80ft. in length and 60ft. in width is bridged over by two large beams which transmit the load to side pillars, while for the ball room a length of 40ft. and a width of 70ft. is covered by a dome which is supported by the roof structure.

Among other structural parts of the hull we may mention the stern post and shaft brackets, which were supplied by Thos. Firth and Sons, Ltd., of Sheffield. The stern post is made in three sections, the lower part of it being carried forward by a heel casting. Both this casting and the casting for the fore foot of the ship were supplied by Firths. The two inner shaft brackets are in the form of separate castings, which are connected together at their upper ends and the outer bracket castings are attached to the hull by strong webs and partial bulkheads.

In Fig. 1 on page 509, the rudder frame and rudder stock assembled in the works of the Darlington Forge, Ltd., are illustrated. The size of the rudder may be judged from the fact that the diameter of the stock is 26½in. and the weight of stock and frame over 65 tons. This heavy forging was loaded on to a special road truck at Darlington, and its transport to Clydebank occupied no less than seven days. The type of rudder adopted may be seen from Fig. 2, and incidentally we may remark that one of the outstanding features of the official trials was the way in which the ship responded instantly to the slightest movement of the wheel, evidence of the excellence of the electro-hydraulic steering gear and telemotor controls, which were constructed and installed by Brown Brothers and Co., Ltd., of Rosebank Ironworks, Edinburgh, to which we hope to refer in more detail in a later article.

Propellers and Tunnel Shafting.

The stern view of the ship reproduced in Fig. 2 illustrates the arrangement of propellers and the design of the propeller bossings. The propellers are made of solid bronze and were cast and finished by the Manganese Bronze and Brass Company, Ltd., of London. They have diameters of 19ft. 3in. and 14ft. respectively for the inner and outer shafts, the corresponding propeller revolutions being 150 and 200 revolutions per minute when the engines are developing the normal service output of 63,000 S.H.P. For pleasure cruising during the winter months the outer propellers will be removed and be replaced by dummy bosses and cones of stream line form. The lower drawing on page 510 shows a plan and elevation of the tunnel shafting. The arrangements for unshipping and handling the spare tail shafts, a full complement of which is carried, may be mentioned. The four lines of propeller shafting are supported throughout by tunnel bearings of the Michell self-lubricating type, constructed by Michell Bearings, Ltd., of Newcastle-upon-Tyne. There are thirty-two such bearings for the 21¼in. diameter inner shafts and twelve for the shorter 15½in. diameter outer shafts. In addition, each shaft has an enlarged bearing carrying two more pads in a hinged cap, which bearings are placed at the aftermost end of the shafts next to the stern glands. We illustrate in Fig. 3 one of the 21¼in. diameter bearings. It will be seen that the two rings mounted on the shaft dip into the well and lift the lubricating oil on to the top centre, where it is caught by the scraper and distributed to the bearing pads. The absence of glands may be noticed, their place being taken by light spring oil deflectors, which in practice have proved most effective. This design of bearing does away with wear and undue heat, while its makers claim a large reduction in bearing friction and in space occupied. What is more important, each and every individual bearing, being self-contained and self-lubricating, it may be trusted to function out of sight and out of mind from the beginning to the end of the longest voyage. To meet an emergency, the bases of the blocks are arranged as water jackets with a connection from the tunnel water service conveniently carried in the tunnel hand rail. Throughout the recent trials of the "Empress of Britain" the bearings were characterised by their coolness and the absence of any necessity for attention, there being no escape of lubricating oil from them on to the shafts.

As may be seen from our drawing, the shafts are provided with the usual trailing collar blocks and brake straps, while at their forward ends a Siemens-Ford torsion meter is fitted. There is a separate length of shaft at the extreme forward end. It carries a single collar standard Michell thrust bearing, which is mounted in a heavy bearing housing having a hinged cover for convenience of inspection. An engineer's workshop is arranged in a tunnel space, and we noted that it was equipped with a lathe, drilling machine, and a full complement of engineers' tools, with an engineers' stores adjoining. In other tunnel compartments are the two electrically-driven refrigerating compressors, which are of the latest vertical enclosed type supplied by J. and E. Hall, Ltd., of Dartford. These CO_2 machines are coupled direct to 64 B.H.P. Laurence-Scott variable-speed motors, and the installation comprises besides the compressors two circular condensers and two circular evaporators, the latter being placed in an insulated room. The installation, which is complete with circulating and brine pumps, is designed to deal with 27,000 cubic feet of insulated cargo space and 29,500 cubic feet of insulated space for domestic and hotel requirements. In addition to the main plant, Messrs. Hall have also supplied a smaller machine and two automatic "Hallmark" machines for service in other parts of the ship.

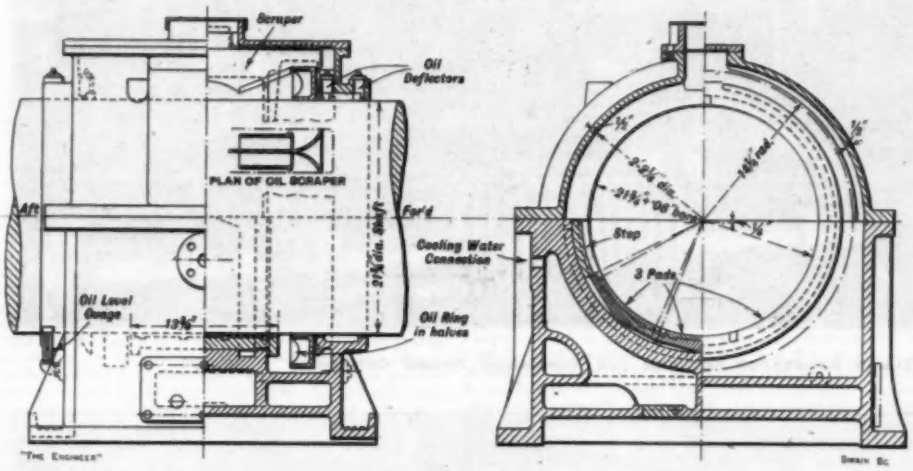


FIG. 3—SELF-LUBRICATING "MICHELL" BEARING FOR TUNNEL SHAFTS

Public Room and Cabin Accommodation.

A full description of the architectural and decorative features of the ship does not fall within the immediate scope of this article, but some reference must, nevertheless, be made to the high standard of excellence which is apparent throughout all the public rooms and passenger accommodation, whether it be for first, second, or third-class passengers or the officers and crew. The builders and sub-contractors are to be congratulated on the way in which the work has been carried out. For the main first-class public rooms a number of well-known British artists were called in to assist Mr. P. A. Staines, R.O.I., and Mr. A. A. Jones, F.R.I.B.A., the owners' decorative architects, in the carrying out and the co-ordination of the whole decorative scheme, in which they were assisted by Mr. R. Whyte, the decorative architect of John Brown and Co., Ltd. The dining saloon, which is designed to seat 452 persons, contains two decorative panels, by Mr. Frank Brangwyn, and was furnished by H. H. Martyn and Co., Ltd., of London, which firm also fitted out the Olympian pool swimming bath. To Mr. Heath Robinson was entrusted the decoration of the Knickerbocker bar, in which he has depicted "The Legend of the Cocktail" in his own whimsical manner. Mr. Robinson also decorated the children's playroom in a fanciful style. The Empress room was designed by Mr. P. A. Staines and serves as a ball room or cinema, a Western-Electric "talkie" projector of the latest type being provided. The centre or Mayfair lounge has been decorated to the design of Sir Charles Allan. From this room a long gallery named the Mall leads to the smoking-room or Cathay lounge, the decoration of which has been fittingly carried out in Chinese style by Mr. Edmund Dulac. Other rooms in this suite include the writing and card rooms, the furnishing of which has been carried out in a befitting and quiet style. In the execution of these decorations and those of the second-class and tourist third-class public rooms the firms of Waring and Gillow, Ltd., H. H. Martyn and Co., Ltd., Hampton and Son, Ltd., and Wylie and Lochead, Ltd., of Glasgow, all took part. Throughout all the different classes from the first-class staterooms and apartments to the third-class cabins a standard of accommodation has been provided which is in keeping with the Canadian Pacific Company's hotel standard. On page 516 four typical views of the first-class apartment cabins are reproduced. The ventilation of the accommodation and living spaces is effected by a system of mechanical ventilation and heating on the "Thermotank" principle, separate systems of trunking being provided for each block of accommodation. Provision for heating by means of low-pressure steam radiators and electric radiators has also been made, and a very complete installation of electric lighting, ranging from flood lights for the funnels through varied systems of indirect lighting to the smallest cabin lamp has been supplied by the General Electric Company, Ltd., of London and Witton.

In a second article we propose to deal with the main turbines and boilers and some of the more interesting features connected with the propelling machinery installation.

(To be continued.)

THE Swedish Water Power Union, in a report for 1930, states that the total water power resources of the country exploited with modern plants at the end of 1930 amounted to 1,277,000 kilowatts, or 1,736,000 H.P. The electric power produced by steam engines was only 340,000 kilowatts. The total production of electric power was 5,250,000,000 kilowatt-hours—of which 4,800,000,000 were produced by water power—compared with 4,982,000,000 in 1929 and 1,450,000,000 in 1913. The report says that Sweden will soon reach the point at which the large and medium-sized water power resources in the south and central parts of the country will be fully exploited. Power plant constructors will then turn more and more to the southern parts of North Sweden (Norrland). The capital invested in the water-power production of electricity in Sweden is estimated at between 900,000,000 kr. and 1,100,000,000 kr. Sweden takes the eleventh place among nations of the world in the annual production of electricity, but, per head of the population, it comes next after Norway and Canada.

TURBO-GENERATOR SETS

THE ENGLISH ELECTRIC COMPANY, LTD., RUGBY, ENGINEERS

(*For description see opposite page.*)

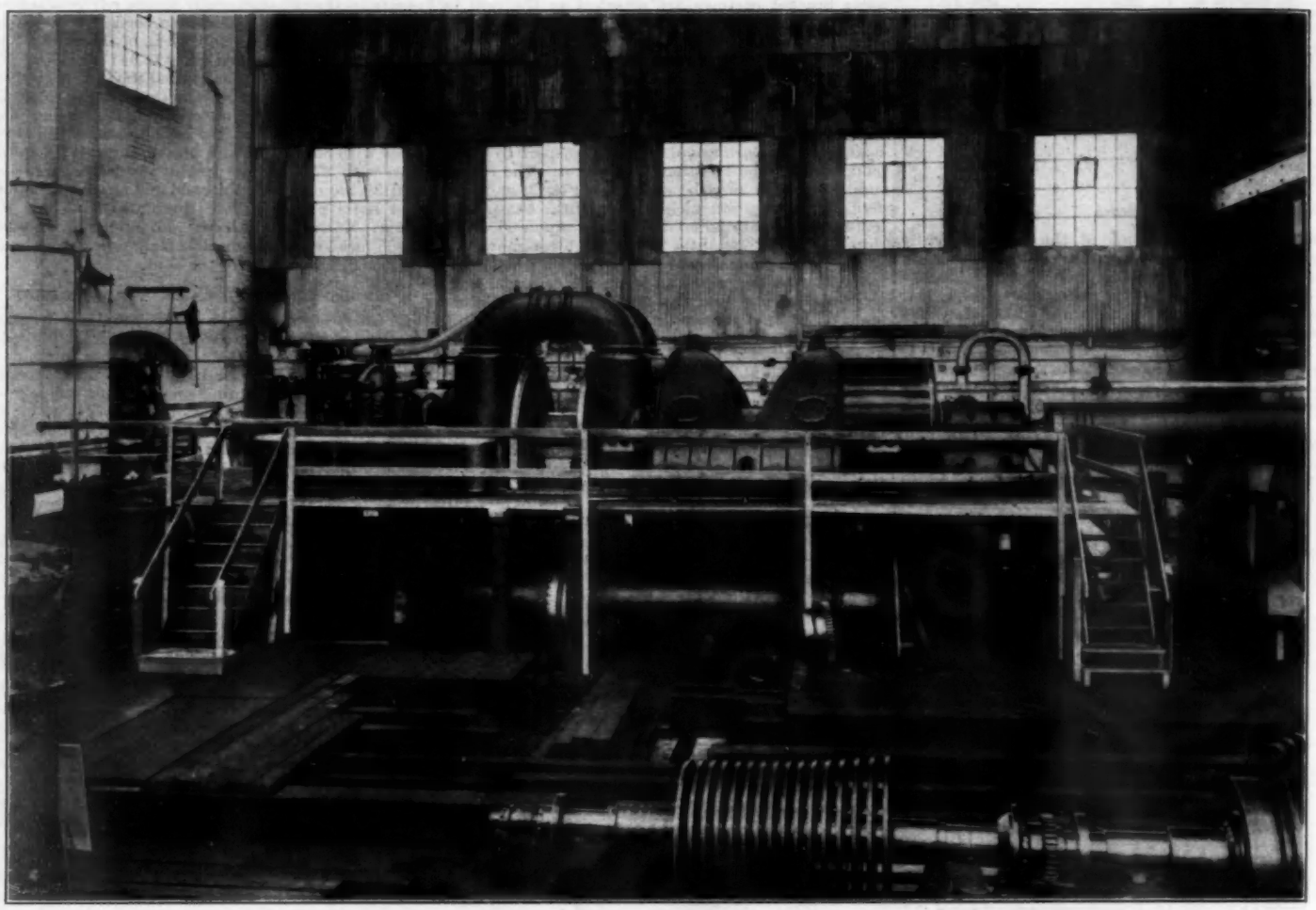


FIG. 1—30,000-KW TURBO-GENERATOR SET FOR THE YORKSHIRE POWER COMPANY

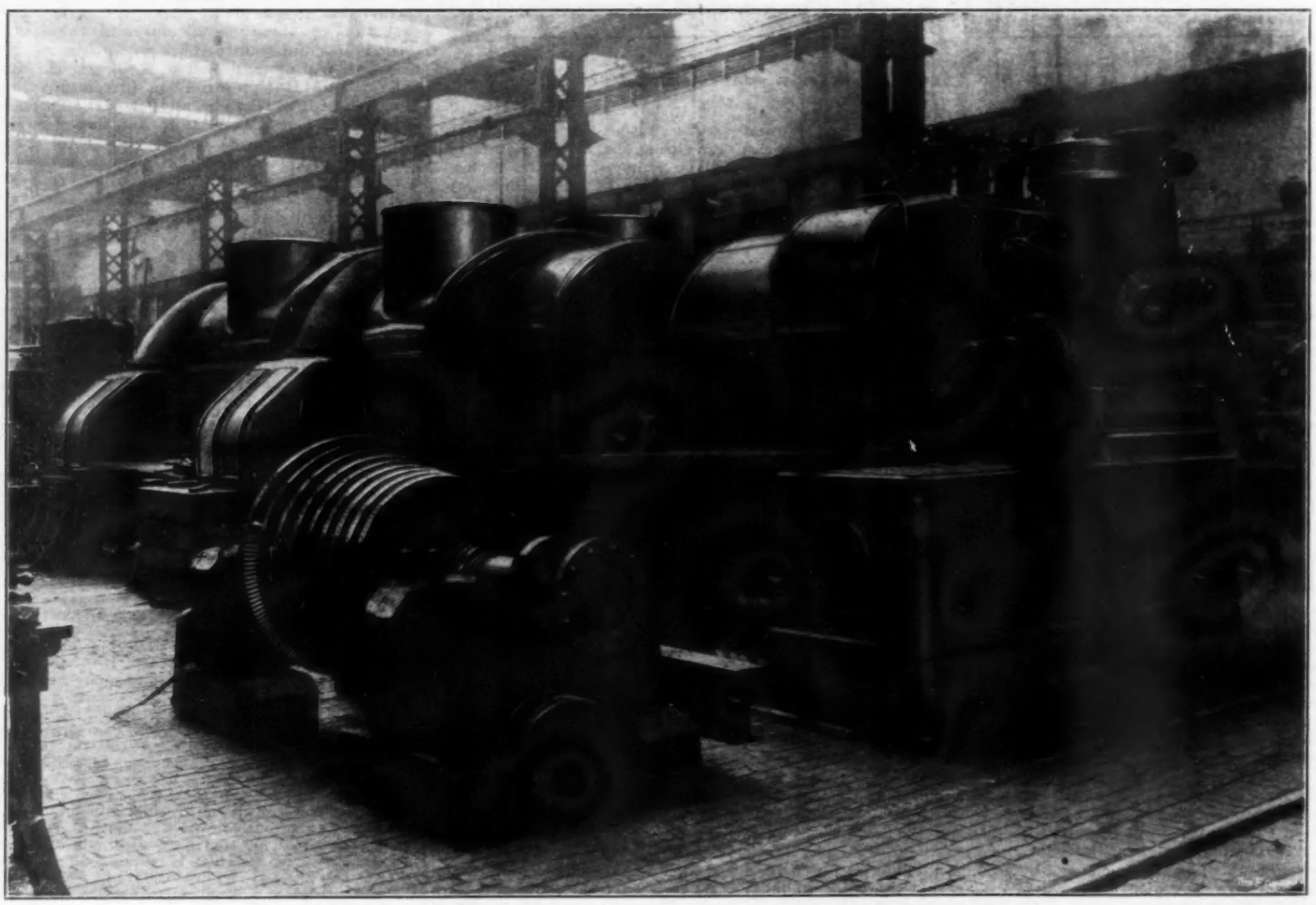
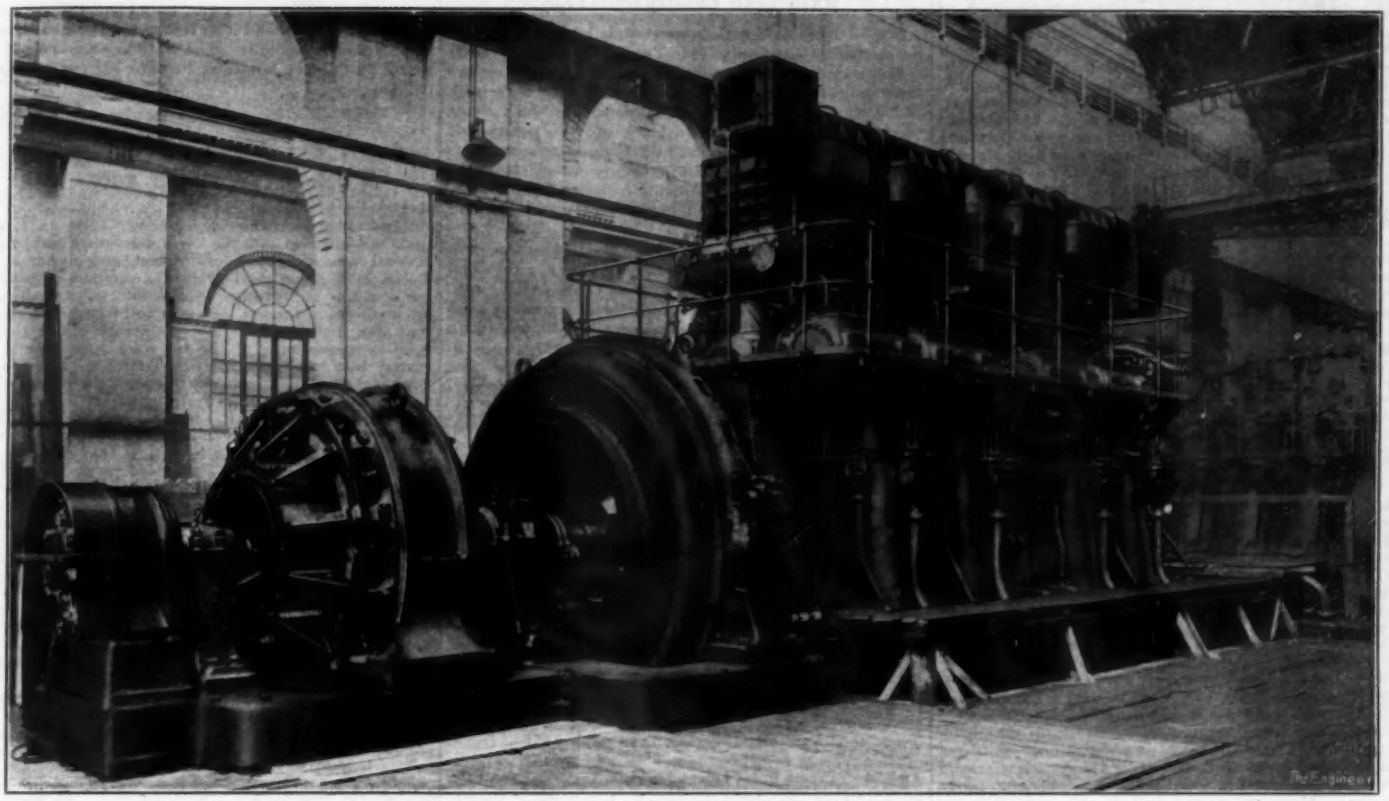


FIG. 2—25,000-KW TURBO-GENERATOR SET FOR THE SHEFFIELD CORPORATION

1500 H.P. FULLAGAR ENGINE AND GENERATORS

THE ENGLISH ELECTRIC COMPANY, LTD., RUGBY, ENGINEERS



A Visit to the Rugby Works of the English Electric Company.

Of the engineering works devoted to the manufacture of prime movers for driving electric generators none are more interesting than the Rugby Works of the English Electric Company. From the days of the Willans central valve engine up to the present time, they have played an important part in the development of prime movers for use in central stations and for nearly thirty years have produced steam turbines. Water turbines and oil engines are also made at Rugby, and the English Electric Company claims that with one possible exception it is the only firm in the world that designs and manufactures in its own shops these three types of prime movers. Besides high-pressure turbines of the largest size, the company manufactures mixed-pressure, back-pressure, and pass-out turbines, which meet the specialised demands of certain industries.

In view of interesting work at present being carried out, a large party of engineers was recently invited to inspect the Rugby factory, when examples of large steam turbines, water turbines, and oil engines were displayed. The party was also conducted through the experimental department, which is maintained for the investigation of the thermal and mechanical problems that arise in the development of new designs. In this department great attention is paid to the natural period of vibration of turbine disc and blades, to the testing of oils, and to other matters that ensure the reliable and safe operation of plant under commercial working conditions. To experimental work the English Electric Company has devoted considerable attention, and has always been ready to cope with new requirements. The company, it will be remembered, was awarded the main contract for the Bradford super pressure plant, and it was at the Rugby works that the first Benson boiler generating steam at 3000 lb. was installed and tested. The steam from this boiler, reduced in pressure and superheated according to the Benson system, was used to drive a turbine specially designed by Mr. Chittenden for the purpose, and at the time of the visit this turbine was exhibited. On the electrical side, the firm has also made several daring experiments, notably in connection with the transverter, but here we are only concerned with the mechanical side of the business, which, in spite of the general trade depression, is apparently doing quite well. The non-basement or surface type of turbine plant was represented on the occasion of the visit by a 2000 kW set, with the exhaust casing mounted directly on the condenser body. For comparatively small outputs, up to about 3000 kW, sets of this type, which run at higher speeds than usual, and which usually drive the generator through gearing, are now frequently installed in industrial power stations and form a compact assembly which can be made completely self-contained with mechanically driven auxiliaries.

For units of large outputs the company has developed the impulse reaction multi-cylinder design of machine, which is built for the highest pressures, and with multi-stage feed heating to give the highest economy. Usually these sets run at a speed of 3000 revolutions per minute, and give a 50-cycle supply with a two-pole alternator. On the occasion of the visit two of these large machines were shown, a 30,000-kW, 3000 r.p.m. machine, for the Yorkshire Electric Power Company, and a 25,000 kW set for the Sheffield Corporation, shown respectively in Figs. 1 and 2 on page 512. The former, which is provided with a complete feed-heating equipment, is similar in design to the unit now in operation at West Ham,* which was the first of its size and speed to be built in this country. The set, which was constructed to the specification of Mr. W. B. Woodhouse, is a three-cylinder machine designed to operate with steam at a pressure of 400 lb. per square inch, and at a total temperature of 750 deg. Fah. At the high-pressure end there are eighteen high-pressure impulse stages, whilst each low-pressure cylinder has nine reaction stages. The Sheffield set shown in Fig. 2 is designed for a steam pressure of 570 lb. per square inch and a total steam temperature of 770 deg. Fah., and has its three cylinders arranged in tandem, the high and intermediate-pressure cylinders being of the impulse type, whilst the low-pressure end consists of a double-flow reaction cylinder, which receives steam at 7 lb. per square inch abs., and exhausts into twin condensers. Like the machine for the Yorkshire Power Company, this set is provided with feed-heating equipment. The set has been constructed to the specification of Mr. E. Morgan, the general manager and engineer to the Sheffield Corporation's electricity department.

Back-pressure turbines were not in evidence at the time of the visit, or, at any rate, they did not come before our notice. Two 10,000-kW units are, however, now being erected in the Yallourn briquetting factory of the State Electricity Commission of Victoria. The specification for these machines provides for a stop valve pressure of 565 lb. per square inch, a steam temperature of 725 deg. Fah., and for a normal back pressure of 55 lb. per square inch, with provision for raising this pressure to 70 lb. per square inch if desired. The machines are of the single-cylinder impulse type, designed for a speed of 3000 revolutions per minute, and each turbine is directly coupled to an English Electric alternator. Some fine examples of surface condensers of various sizes were on view, together with feed-water heaters and oil coolers, all made at Rugby.

The water turbine section of the works has manufactured plant for hydro-electric undertakings in many parts of the world, and the generators to which the turbines are coupled have been made at the company's Stafford works. For the manufacture of hydro-electric plant for use in this country, as, for example, the plant for the Falls of Clyde undertaking and the Lochaber scheme, the English Electric Company has been responsible. The 6000 H.P. water turbine and alternator shown in Fig. 3 is to be installed at the Kurra Falls, Nigeria, and at the time of our visit to Rugby it was erected in the turbine shop with its main valve and alternator. The turbine is a reaction machine, with its overhung runner bolted to the end of the alternator shaft, and is designed to run at 1000 r.p.m. under a static head of 720ft. The cylindrical balanced valve, which is hydraulically operated, is of the firm's patented stream-line type, with an inlet diameter of 36in. Balanced valves of this type have been brought to a high stage of perfection, and are made for a variety of hydraulic purposes besides that of controlling turbines. The considerations which govern their design also apply to valves for general hydraulic engineering purposes, where the head, quantity of water, and service conditions are as a rule less exacting, and they have been found to be thoroughly satisfactory for use in connection with water supply, pumping, irrigation, and similiar hydraulic works. It should be pointed out that the firm's stream-line valves are only intended to open and close down the flow of water through pipe lines. Although capable of regulating the flow, they are not intended to do so, and for this purpose the company manufactures a stream line diffusing discharge regulator, which is also of the cylindrical balanced type, and is suitable for regulating the discharge from storage reservoirs. The stream-line cylindrical balanced valve has been developed for fully automatic remote

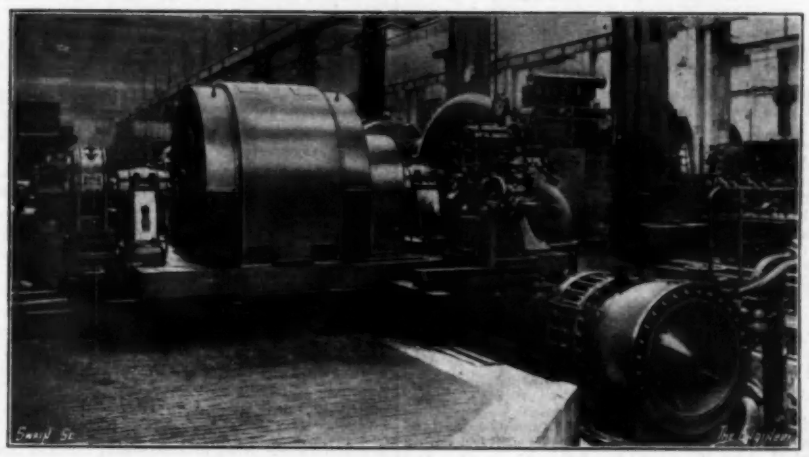


FIG. 3—6000 H.P. WATER TURBINE AND ALTERNATOR

* See THE ENGINEER, January 2nd, 1931.

control, so that it can be used in conjunction with automatic power stations. Remote controlled valves can also be placed in a distant part of a pipe line. In order to obtain rapid operation without undue pressure rise in the pipe line and freedom from "slam shutting," the valves are provided with a specially designed balanced cylindrical piston and a travelling control valve.

Of the oil engines on view one of the most interesting was the eight-cylinder, 1500 B.H.P. Fullagar engine, shown on page 513, which has been built for the Karachi Electric Supply Company. It runs at a speed of 250 r.p.m. and is directly coupled to a three-phase, 850 kW alternator, and a D.C. generator of the same output. The set is similar to others supplied to the Leatherhead and District Electric Supply Company and to the Bermuda Electric Power and Traction Company, which already has three Fullagar engines operating in its power station. For this company the English Electric Company is also supplying a 2250 B.H.P., six-cylinder engine, coupled to a three-phase alternator, and at the time of the visit the engine was running on test. Since 1920 many of these Fullagar two-stroke engines have been built. At the present time a four-crank Fullagar engine, which develops 900 B.H.P. at a speed of 300 r.p.m., is being used for experimental purposes, whilst supplying power to the Rugby Works, one of the lines of the engine being fitted with airless fuel injection gear, which will shortly be applied to the other three cylinders, this being the first Fullagar engine on which this gear has been tested. The Fullagar opposed piston type of crude oil engine was described in our issue of April 28th, 1922, and it is scarcely necessary to deal with it in detail here. Briefly, the special feature of the engine is that it has only one crank and connecting-rod per cylinder, as compared with three cranks per cylinder in other opposed piston engines. For a given output the design leads to cylinders of small size, in spite of the low mean effective pressure and piston speed which have been adopted. The engine, which is built with four, six, or eight-cylinder units in sizes ranging from 750 B.H.P. to 3000 B.H.P., is actually a double-acting, two-stroke cycle engine, without cylinder covers. There are no exhaust valves or air inlet valves, which, in the ordinary oil engine, form a large proportion of the component parts. Owing to the fact that the centres of gravity of the reciprocating masses working side by side nearly coincide, good balance is secured, thus ensuring even running at comparatively high speeds, and a small cyclic variation with a fly-wheel of medium size. Because of the special construction and good balance, a low piston speed and high speed of rotation are attained, whilst, as each connecting-rod is double-acting and the effort on each crank is uniform in one direction, there is uniformity of torque. Moreover, as the pull on one connecting-rod is largely counteracted by the thrust on the adjoining rod, there is a small load on the main bearings, whilst, as the direct stresses caused by the pressure between the pistons are not transmitted to the frame, the stresses in the frame are low. As is well known, the Fullagar engine occupies a relatively small amount of floor space for its output, as compared with that required by an ordinary oil engine of corresponding output.

That the English Electric Company also manufactures Diesel oil engines is, however, well known, and on the occasion of our visit to Rugby a number of these engines were in evidence. Diesel engines of the four-stroke type have been manufactured by the company since 1906, and are still produced to meet the demand for units of comparatively small power. For the equipment of the power station at Wad Medani the company is supplying, as part of a comprehensive contract, three of its standard three-crank, four-stroke Diesel engines, each having an output of 243 B.H.P. at a speed of 214 revolutions per minute, and each engine is to be directly coupled to an English Electric alternator.

Obituary.

WILLIAM JOHN ANDERSON.

We hear, with regret, of the death of Mr. William John Anderson, who was managing director of Wright, Anderson and Co., Ltd., structural engineers, of Gateshead-on-Tyne and London. Mr. Anderson was born in 1869 in Gateshead, and after finishing his education at private schools, was apprenticed to John Abbott and Co., Ltd., with whom he remained many years after his indentures were completed. In 1908 Mr. J. Wright asked him to join him as partner in a structural engineering business, which he did. The firm did well, and in due course Mr. Anderson became managing director. We understand that the business will, for the present at any rate, be carried on just as before, but with a director short. Mr. Anderson was elected an associate member of the Institution of Mechanical Engineers in 1907, and a full member in 1914. His death at a relatively early age robs the firm of a valuable and greatly respected member.

HERBERT MORRIS.

It is with regret that we have to announce the death of Mr. Herbert Morris, the founder, chairman and managing director of Herbert Morris, Ltd., of Loughborough. Mr. Morris, who died recently at Nice, was educated at Bedford Grammar School, after leaving which he assisted his father, a distinguished civil servant, in the carrying on of a business directory. It was in 1884 that he founded the engineering business of Herbert Morris, Ltd., at Loughborough. In the early years of the undertaking he was joined by Mr. Frank Bastert, who retired in 1911. The business grew from small beginnings to one of the largest in the world devoted exclusively to the manufacture of lifting and conveying machinery. It had subsidiary companies in Canada, France, and America, and agencies in many other countries. Mr. Morris took no part in public life, and did not associate himself with any scientific societies or technical institutions. Had he not been a man of such a quiet and retiring disposition, there is no doubt that he would have become known as one of the great industrialists of his age. He was closely identified with the developments of his company, both on the technical and commercial sides, and his great intellectual gifts were undoubtedly large factors in advancing the extended use of the many lifting and conveying plants and schemes with which his company was associated.

Letters to the Editor.

(We do not hold ourselves responsible for the opinions of our correspondents.)

MAIN LINE ELECTRIFICATION.

SIR,—I have read with interest your leading article on the electrification of railways in THE ENGINEER of May 1st.

Not very long ago you based a leading article on the same subject upon some remarks of mine in my little book on Railways in Benn's Sixpenny Library. You will perhaps therefore allow me to direct attention to two points that struck me at once as I perused the Committee's report.

(1) Their complete neglect to take into consideration the improved results to be anticipated from steam locomotives of the ordinary kind, but of improved design and more energetically driven.

For more than thirty years I have given close attention to the work of the steam locomotives of the principal French railways. I have found that those engines constantly develop powers per ton-weight of engine at least 30 per cent. greater than the best efforts of British steam locomotives. In your issue of July 22nd, 1927, you published an article by me describing some of this sort of work. I have records of numerous other similar performances.

In the Committee's report one of the estimated advantages of the electrification of the Crewe–Carlisle line is stated to be a reduction to 143 min. in the time required for passenger trains to run the 141 miles. From my own personal experience, I say with the utmost confidence that there are hundreds of French steam locomotives, of weight no greater than that of the bigger express engines in this country, whose drivers would, with trains of the weight contemplated in the report, perform work just as hard, and think nothing of it.

(2) The Committee draw particular attention to the advantages to be secured by "standardised units"—see paragraph 54 of report. If there is a machine in the world that should not, for the present and for a long time to come, be standardised, it is the electric express locomotive. There is every sort of defect to be eliminated. For example, no satisfactory method has yet been discovered of transmitting power from the motor to the driving wheels. All arrangements so far tried have a tendency to pound the road. Then, one of the supposed advantages of electric locomotives is that they need not be turned. But how can this be reconciled with the fact that the qualities required in a leading bogie are quite different from those required in a trailing bogie?

Only a year or two ago the Paris–Orleans Company were finding the most serious difficulties in the way of designing a satisfactory electric express engine. They were, at very great expense, trying engines of the most diverse kinds, and, so far as I know, their difficulties are nothing like over.

MONKSWELL.

London, W. 2, May 4th.

WORLD INDUSTRIAL DEPRESSION.

SIR,—THE ENGINEER has lately published several very fine leading articles on economics. The Editor might be interested to know of a lecture by Professor Bonn, at the Society of Arts, about six days ago, ostensibly on the free competitive system, free exchange, as opposed to monopolies and tariff barriers, but mainly on his study of world industrial depression and its cause. It was a crowded gathering, but I did not see that it was reported. Since then I heard that a report would be issued for 1s. The Editor of the *Economist* presided. From the lecture I gathered that the cause of the industrial depression, in the lecturer's view, was the super-production of labour-saving machinery in every field—agriculture, mining, manufactures, &c.—which so effectively dispensed with labour, in causing world-wide dis-employment, that the markets for which this mass production machinery had been produced had dwindled away through the loss of those customers who had previously had the means to buy, and these, taking the world altogether—registered disemployed and unregistered disemployed in many grades of society—amounted to many millions. The figures were estimated. Thus the world was now stocked with grain and mass-produced commodities of every kind which could not be sold cheaply, although people were starving for them, and in following the imaginary law of "supply and demand," because the millions invested on this labour-saving machinery were bound to give the investors their due interest—in this country, investments, good and bad, average 8½ per cent. interest—and for this reason stocks were being held back to keep up prices. The lecturer could foresee no change in this state of things for very many years to come—he stated some term of years—because the populations were not increasing in proportion to the labour-disemploying machines and devices constantly being put on the market in further dispensing with the customers who formerly bought products such as they produce. To the ordinary listener, as myself, it appeared to be a vicious circle of defeatism, based on the creation of disemployment and of killing the "goose that lays the golden eggs"—the consumer—who is, taking the mass of the world's population, the common worker. Yet Governments and great corporations everywhere are planning schemes to further save labour and thereby to reduce consumers.

As THE ENGINEER has already printed articles with similar reasonings, I think Professor Bonn's lecture, in full, would provide matter for a good leading article on world industrial depression. Four hundred million pounds on electrification must give its due money interest, and with current supplied to railways at 0·5d. per kilowatt-hour, against steam locomotives at 0·428d. at draw-bar, fire-lighting included, the saving must necessarily come about by disemployment—firemen, boilermakers, heavy engineering industries, locomotive works plants, &c. The same sum spent to "electrify" house building, with rents still three times pre-war, would penetrate at once to those who would spend it as fast as they earned it, and so make trade prosperous. The lecturer should have been heard by Cabinet Ministers to have been of use, in my opinion.

May 5th. C. R. K.

SIXTY YEARS AGO.

A BRIEF note in our issue of May 12th, 1871, shows that even in those days the low-temperature carbonisation of coal was a subject of interest and research. Dr. Eveleigh, it seems, had evolved a method of producing gas at a low temperature in iron retorts. Details of the process were not given, but it is to be gathered that the coal was distilled at a low temperature and that the volatile constituents of the tar were subsequently converted into permanent gas. The gas produced was described as being much less offensive than ordinary gas and to be very rich in hydrocarbons. It was so rich, in fact, that it could not be burnt in a standard Argand burner with fifteen holes and a 7in. chimney at a greater rate than 4 cubic feet per hour. At that rate it gave a light equal to that of 15·7 standard sperm candles. . . . Meanwhile, in the United States, new wonders were appearing. At New Orleans on April 9th, Mr. J. B. Knight, agent of the Watertown Steam Engine Company, was sinking a well at the rear of his office for the purpose of obtaining a supply of water. When the well had reached a depth of 46ft. a sudden and very powerful draught of gas was observed to flow from it. Mr. Knight immediately tried to close the pipe, thinking to employ the gas for illuminating purposes, but he found that the pressure was too great to permit him to carry out his purpose. He seems, from our account, to have had the idea of burning the gas under steam boilers, but, apparently, in an accidental manner, he discovered that the pressure of the gas, given as 12 lb. per square inch, was sufficient without combustion to operate a steam engine. After the gas had performed work in the engine, it was ignited at the exhaust for illuminating purposes. . . . In a leading article we directed strong criticism on the Board of Admiralty and Mr. Childers, the First Lord. When Mr. Childers took office in 1869, he found an organisation in existence which had been established in 1832. The organisation had its defects, particularly as it related to the management of the dockyards. Mr. Childers immediately proceeded to alter it, but his ideas on the subject of reorganisation, so we implied, began and ended with concentrating supreme power in his own hands. He dispensed with or limited the authority of the four Naval Lords, the Civil Lord, the Controller and the Parliamentary and Permanent Secretaries. The changes were severely criticised, and Members of Parliament succeeded in getting a committee appointed to inquire into them. That committee reported and condemned Mr. Childers' system in sweeping terms. The changes which he had introduced, we said, were not those which were wanted. Their result had been to leave us with an Admiralty practically speaking without a Controller or a Chief Constructor, and with a First Lord, who, having first taken all the business into his own hands, had broken down and had been compelled to leave the country at a moment when it was hovering on the edge of war.

INSTITUTION OF NAVAL ARCHITECTS.

As previously announced, the Summer Meeting of the Institution of Naval Architects will be held in Paris from June 29th to July 4th. On Monday evening, June 29th, there will be an informal reception at the Hotel George V., when members and guests will be welcomed by the Reception Committee of the Association Technique Maritime et Aeronautique.

The first meeting will be held on June 30th, at the Salle d'Iéna, 24, Avenue d'Iéna, at 9.30 a.m., when three papers will be taken. These will include a paper by Sir J. H. Biles, Honorary Vice-president of the Institution, on "The Draught and Dimensions of the Most Economical Ship," after which M. Charles François, Director-General of the Shipbuilding Department of the Ministry of Marine, will read a paper on "Notes on Some Researches and Tendencies of Contemporary Shipbuilding," while Mr. J. L. Kent will follow with a paper on "The Effect of Rough Water on the Propulsion of Single-screw Ships."

On the afternoon of Tuesday the party will visit the Invalides, while on the evening of the same day a reception will take place at the Ministry of Marine.

Wednesday morning, July 1st, will be given up to visiting the Vincennes Exhibition, at which luncheon will be taken, while in the afternoon there will be a reception at the Chamber of Commerce of Paris. The Institution banquet will take place the same evening. The reading and the discussion of technical papers will be resumed at the Salle d'Iéna on Thursday at 10 a.m., when M. Louis Kahn, late Chief of the Technical Staff at the French Air Ministry, will read a paper on "Technique and the Use of Aircraft and their Relation to Naval Technique." Mr. A. T. Wall and Mr. H. C. Carey will present a paper on "The Effect of Modern Machinery on the Design of Large Ships," while the last paper to be taken will be one by Monsieur Paul Dumanois, Director of the Technical Department of the Oil Fuel Board, on "Remarks Relative to the Development of Marine Internal Combustion Engines."

In the afternoon the aerodrome at Le Bourget will be visited, this event being followed by an evening reception in the Pré Catelan. On Friday, July 3rd, an excursion by train and motor will be made to the Chateaux de la Loire, and the following day the shipyards at Saint Nazaire will be inspected.

Railway and Road Matters.

THE London and North-Eastern is laying in the main line north of Thirsk rails of a length of 90ft. The present maximum length on British railways is 60ft.

AT a meeting of the Railway Rates Tribunal on April 21st the President, addressing the representative of the railway companies, said that it would be of assistance if the Court could be told now whether the railways had any intention to propose any alteration or amendment of rates at the annual review called for by the Act of 1921. Mr. Cole Deacon, in reply, said that there was no such intention.

THE Great Northern (of Ireland) is imitating to a small degree the example set by its neighbour, the Great Southern, in converting some double line into single track. The length selected is the 12¼ miles between Monaghan and Clones. The rails, sleepers, &c., which are being taken up are good and thoroughly serviceable, and they will be used elsewhere and thereby obviate the necessity this year of bringing new materials for the company's usual relaying programme.

A NEW steel rail, heavier and much stronger than any hitherto in regular use on any railway, has just been adopted by the Pennsylvania Railroad. The new rail has been designed to sustain 100,000 lb. axle loads at a speed of 100 miles an hour, compared with the maximum present requirements of 80,000 lb. axle loads and a speed of 80 miles an hour. Its weight is 152 lb. to the yard, and it possesses about 75 per cent. greater stiffness than the Pennsylvania's present 130 lb. standard section rail for main line use.

To those who know the country or who travel regularly by the former Midland route to and from Manchester there was an interesting illustrated article in a recent *Manchester Guardian* descriptive of the 1¼ miles widening from two to four lines immediately to the south of Ambergate. That work includes the opening out of Longlands Tunnel over 100 yards in length, which necessitates the removal of 100,000 cubic yards of good Derbyshire gritstone. It has a five-course brick lining which is being blown up in sections. The first section, of 30ft., was removed on April 19th, and the next will be done on May 17th.

REPLYING to a suggestion at the Great Western meeting that "Many shareholders would like to see some of those connected with the working of the railway placed on the board of directors," the chairman said: "If I were a retired officer on the railway and I were put on the board I should feel it might embarrass the gentleman who succeeded me in my office to have me sitting there in judgment on him when, very often, proposals which he might think fit to make in good faith may have been slightly in conflict with what I myself previously recommended. I am certain that, for the sake of the smooth, satisfactory and effective working of the concern, our policy is the better one."

THE first meeting of the Joint Committee of both Houses which is to consider the London Transport Bill was held on Tuesday, April 28th, and was adjourned until May 12th, so that the agreement arrived at between the Ministry of Transport and the "Underground" group could be approved by the shareholders of the latter, as in that event the passage of the Bill would be greatly assisted. The agreement was so approved by a large majority on May 1st. The occasion was made noteworthy for the vehement protest of Sir Robert Perks that it would be far wiser to continue the control of that great undertaking in the hands, not of Government officials, but of men who had had lifelong experience; he hoped that the Bill would be flung out.

THE notices of the electrification of railways report that have appeared in THE ENGINEER may be supplemented by the intimation that Mr. J. A. Parkinson, who, it should be noted, is the Parliamentary Secretary to the Minister of Transport, speaking in the Ormskirk division on April 25th, said that the electrification of railways would be the biggest thing Great Britain had ever handled. They were told that it would cost the Government hundreds of millions, but that statement was entirely wrong. The railway companies had large sums of money invested, and the Government were going to compel the people who own these railways to bring them up to date and make them efficient. The railways have a tremendous amount of money invested, and they would have to spend it.

DURING the year 1930 the London, Midland and Scottish renewed 187 engines—34 by outside firms—heavily repaired 3288, and gave light repairs to 4509. At the end of the year 377 engines were under or awaiting repairs, as compared with 554 at the end of 1929. The London and North-Eastern renewed 74—20 by contract—heavily repaired 2845, and gave light repairs to 1933. They were 536 engines under or awaiting repair, as compared with 564 a year previously. The Great Western renewed 228—129 by outside firms—and gave heavy repairs to 1111 and light repairs to 1562. The engines under or awaiting repairs, numbered 339, as against 445 at the end of 1929. The Southern renewed 15—all in their own shops—heavily repaired 842 and lightly repaired 322. The number under or awaiting repair was 151, as compared with 153 at the end of the preceding year.

THE happy appreciation of the work of all ranks in the railway service, expressed by Sir Ralph Wedgwood at the Railway Benevolent Fund dinner on April 29th, deserves to be put upon record. Sir Ralph, in responding to the toast of the evening, said that the Institution was supported by all grades of railway servants, and proceeded: "The man on the line carries out his duties with amazing efficiency and with an amazing lack of mistakes. That is due to one thing, and one thing only—the very strong spirit which we have in the railway service, a pride in the services and a sense of the honour and responsibility of the position that we exercise. I believe that that runs through all ranks, from the highest to the lowest. It is to that, and that only, that the wonderful record of the English railways, not merely in safety, but the general satisfaction that the railwaymen give to the public, is due. This Institution is the creation of that spirit; it is the embodiment of the pride of the railwayman in his work and in his desire to see that his work is carried out in the most efficient and best possible manner."

Notes and Memoranda.

THE pitchblende discovered at Great Bear Lake, in the North-West Territories of Canada, is said to be worth at least 8600 dollars per ton for its radium content alone. The cost of conveying the ore from the mines to railhead is, at present, 400 dollars per ton.

A STATISTICAL table of the City of Birmingham Gas Department shows that 2783 meters, or 3·3 per cent., were rejected last year, as against 2·95 per cent. in the previous year. Of 4561 wet meters tested, 153 were rejected, and of 77,711 dry meters tested, 2630 were incorrect.

IT is suggested by High Speed Steel Alloys, Ltd., of Widnes, that grey cast iron containing 0·4 per cent. of molybdenum, with 1·65 per cent. of silicon and 3·0 per cent. of carbon has a transverse strength of 5000 lb., as compared with 3200 lb. without the addition of the molybdenum.

A PAPER contributed to the Electrochemical Society of America by Messrs. C. G. Fink and F. L. Jones, of the Columbia University and the Mellon University, gives some detailed particulars of a process for the electro-deposition of tungsten from aqueous solutions. It is suggested that adherent deposits of a lustrous and highly corrosive resistant qualities can be obtained.

LECTURING on Joseph Priestley at the Royal Institution on April 24th, Sir Philip Hartog said: "One of Priestley's most notable achievements was to define as the object of science 'to comprehend things clearly and to comprise as much knowledge as possible in the smallest compass.' The hypothesis was, according to Priestley, only a temporary expedient, finally to be eliminated from 'the perfect theory of the facts.'"

THE new vanadium reduction plant of the Rhodesia Broken Hill Development Company in Northern Rhodesia has started work, its initial output being 10 tons of the fused oxide containing 90 per cent. vanadium pentoxide. The vanadium occurs in fairly concentrated form in the outer margin of pipe-like deposits of oxidised zinc-lead ore, from which it is mined selectively, the minerals being principally decloizite and vanadinite.

IN replying to the discussion on a paper on steam generators which he gave before the Institution of Engineers-in-Charge, Mr. G. A. Plummer explained how the resistance to the pulling out of water tubes, from their tube plates, had been increased by more than 2½ times by making a slight groove, or recess, in the hole drilled in the tube plate and expanding the tube into this groove. He said that in this way the resistance of a 3¼in. tube was increased from 32,300 lb. up to 78,300 lb.

ACCORDING to Mr. O. P. Watts, of the University of Wisconsin, the merits of using a hot solution in the electro-plating of nickel are: Three to ten times the output from the same volume of solution; the possibility of obtaining a thicker, more protective deposit in less time than from the cold solution; a softer, more ductile deposit that is less likely to peel in buffing or in subsequent use. Its disadvantages are a mat deposit which requires buffing, and increased liability to pitting of the deposit from hydrogen. The latter is controlled by additions of hydrogen peroxide or sodium perborate, the preference being three to one in favour of the former.

THE work which has for some months been in progress on other sections of the Grand Union Canal Company's system is now to be extended to the London Area. This is part of the programme for bringing the canals up to date, and making them suitable for navigation by motor barges. The work consists of walling and piling, which is necessary to protect the canal banks against erosion due to the wash from faster and more powerful craft, and dredging to provide an extra depth of 1ft. of water. In view of their efforts to secure greater efficiency the company are urging owners of barges, boats and other craft trading on the canal to invest their capital in boats of the greatest possible carrying capacity. At present the locks on the Regent's section are the biggest on the Grand Union's system, but those which are to be built on the Warwickshire section between Birmingham and Napton will be much larger.

THE Imperial Institute Advisory Committee on Timbers considered that a number of Empire timbers examined by it in the course of its work would prove to be markedly fire resistant, and requested that these woods should be subjected to official tests by the London County Council with a view to their recognition as fire-resistant materials, if found satisfactory. As the outcome of this action, the following Empire timbers have been approved by the London County Council for use as fire-resisting hardwoods:—Andaman Padauk; Iroko, Odum or African Teak from Nigeria and the Gold Coast; African Walnut from Nigeria; Mora and Crabwood from British Guiana. Specimens of all these timbers have been supplied by the Imperial Institute to the Superintendeing Architect and to forty-three district surveyors of the London County Council. Samples of these woods may be seen and information regarding them obtained at the Imperial Institute, South Kensington, London, S.W. 7.

IN a paper contributed to the Electrochemical Society of America, Mr. C. McMullen gives some notes on the commercial application of silicon carbide. Among these he mentions ceramically bonded silicon carbide, which offers a high resistance to the flow of electrical current at low voltages. Its characteristics undergo a rapid change above certain potentials and it becomes a very good conductor. The current varies approximately as the fourth power of the applied voltage. These properties render it useful in the manufacture of lightning arresters. Under ordinary conditions a piece of bonded silicon carbide between the aerial and ground connections of a radio circuit in no way interferes with the operation of the set. However, should lightning happen to strike the antenna, the potential is raised well above that voltage necessary to transform the silicon carbide into a good electrical conductor, and, hence, the charge is carried harmlessly to the ground. A device similar to this is also in use for the protection of power transmission lines from high voltage surges which might ruin transformers and other equipment. A still more recent development along this line is a "flash-over" device, which can be built to act at a definite voltage.

Miscellanea.

IT is proposed to construct a bridge over the river Guadiana at Sobon, Spain.

A NITRIC acid factory with an annual capacity of 5000 tons is to be put up in Roumania.

A NEW company, with a capital of £300,000, is being formed in the Transvaal for extracting oil from coal and torbanite.

THE old Government aerodrome at Arundel has been acquired by the Ford Company of America for the assembly of aeroplanes.

AN installation for the production of cast iron with powdered coal instead of coke has been set up in Walsall by Mason and Burns, Ltd.

IT is reported that a Russian Trade Mission is shortly to visit the North-East Coast with power to spend from £20,000,000 to £25,000,000.

THE Chinese arsenals at Tsinan and Kaifeng have been closed down for military purposes, and are to be converted for the manufacture of cotton seed oil and nitrates respectively.

THE new motor lifeboat at Lytham St. Anne, while lying at her moorings, was in collision with a steamboat. The impact turned her right over, but she righted herself without harm.

THE Pennsylvania Railroad, of America, is adopting a rail weighing 152 lb. per yard, to meet the requirements of new axle loads, which are said to amount to 100,000 lb. per axle at speeds of 100 miles per hour.

THE Government of Yugoslavia proposes to improve the port of Belgrade-Sara, by the building of some new quays and warehouses, an aqueduct, at least twelve new cranes, and the provision of a service vessel for ice-breaking.

BY starting its new McIndoes hydro-electric plant on the Upper Connecticut River, which has an output of 16,500 horse-power, the New England Power Association has increased its total capacity to 1,148,000 horse-power.

ACCORDING to *Indian Engineering*, American financial interests have secured the working control of the Karachi Electric Supply Corporation and also of the leading electric enterprises in the Bombay Presidency and in Poona.

IT is reported from the United States that a new process of smelting zinc from its ores by means of natural gas or methane has been evolved by Mr. C. G. Maier, of the Bureau of Mines. It is said that the resultant metal is 99·99 pure.

THE Cornaire Water Power Bill, which was signed on April 29th by the Governor, Mr. Franklin Roosevelt, commits the State of New York to the expenditure of £34,200,000 on hydro-electric development on the St. Lawrence River at Massena Point.

THE Moorside Edge station of the British Broadcasting Corporation has been completed. It is situated some 5 miles from Huddersfield, and has three 500ft. masts. Work has been started on a station near Falkirk in Scotland, and a fourth is to be arranged in Somerset.

WE are informed that Mr. R. Borlase Matthews, of Greater Felcourt, East Grinstead, proposes to conduct a short electro-farming course at his farm from August 5th to 29th. Those attending this course will be given both practical and theoretical training, and at the same time study the outstanding electrical requirements of farmers.

IT is proposed that the Birmingham Corporation should purchase from the Tame and Rea District Drainage Board the site of the British Industries Fair at Castle Bromwich. It has an area of about 47 acres and the purchase price is put at £31,780. At present the Chamber of Commerce pays an annual rental of £1589 for the ground on a short lease.

IT is estimated that the total footage developed by the Randfontein Estates during 1930 amounted to upwards of 19 miles. This is, says the *S.A. Mining and Engineering Journal*, more than was done on the whole Rand in a year thirty years ago. It is estimated that the total development accomplished on the whole Rand during last year was upwards of 221 miles.

THERE are at present twenty-four patrol cars employed by the Radio Branch of the Canadian Department of Marine for detecting radio interference. Each car has a loop erected permanently on the roof and the control is brought through the roof and placed so that the loop direction can be changed by the driver. A low-capacity lead connects the loop with an eight-tube superheterodyne receiver, which is mounted in a portable case and may be supplied either from the batteries contained in another portable cabinet or from storage batteries carried in a compartment in the car.

THE three flying boats of the "Kent" type, which are being built at Rochester for Imperial Airways, Ltd., for use on the Trans-Mediterranean air service between Genoa and Alexandria, serving both the Indian and African air routes, will be fitted with the latest design of Marconi apparatus, which will give them a wireless range of up to 500 miles. Power for the installation is supplied by a wind-driven generator operating in the slip stream of the propellers. When the flying boat has descended on the water, the generator can be driven by the aircraft gas starter engine. A light mast is carried to support the aerial when the aircraft is at rest, but under normal flying conditions a trailing aerial will be used.

PURCHASING agents and buyers of leading industrial firms, spending millions of pounds a year, will hold a conference on works and factory purchasing in London on June 5th. The chief speakers at the conference will be Mr. Allan R. Baker, chairman, Baker Perkins Ltd.; Mr. E. J. Fox, managing director, Stanton Ironworks Company, Ltd.; Mr. J. Gibson Jarvie, chairman, United Dominions' Trust, Ltd.; Mr. Hugh Quigley, Chief Statistician, Central Electricity Board; Mr. L. H. Swinbank, controller of purchases, Imperial Chemical Industries, Ltd., and Mr. Reginald Pugh. Full information about the conference may be obtained from Mr. Stanley Townsend, 68, Victoria-street, Westminster, S.W. 1; telephone Victoria 3374.

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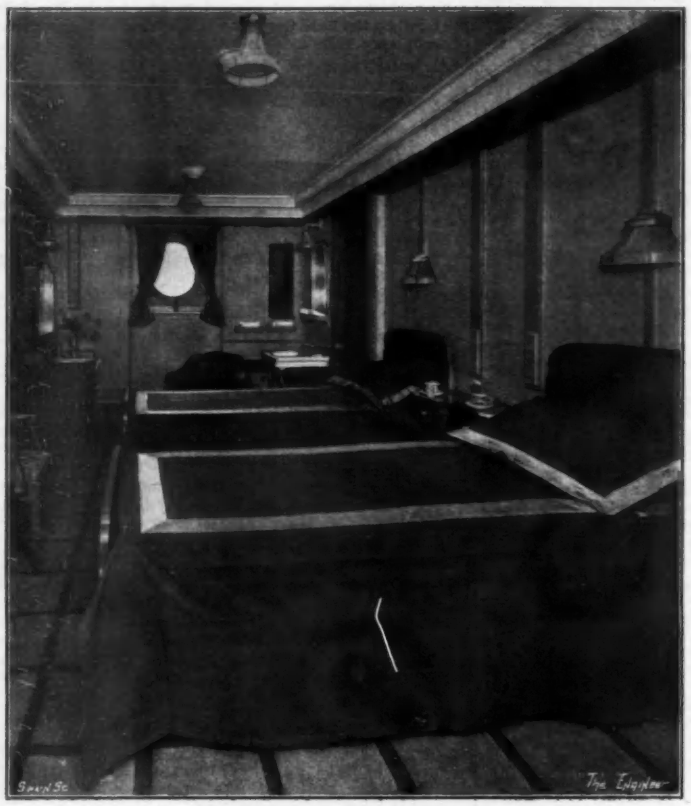

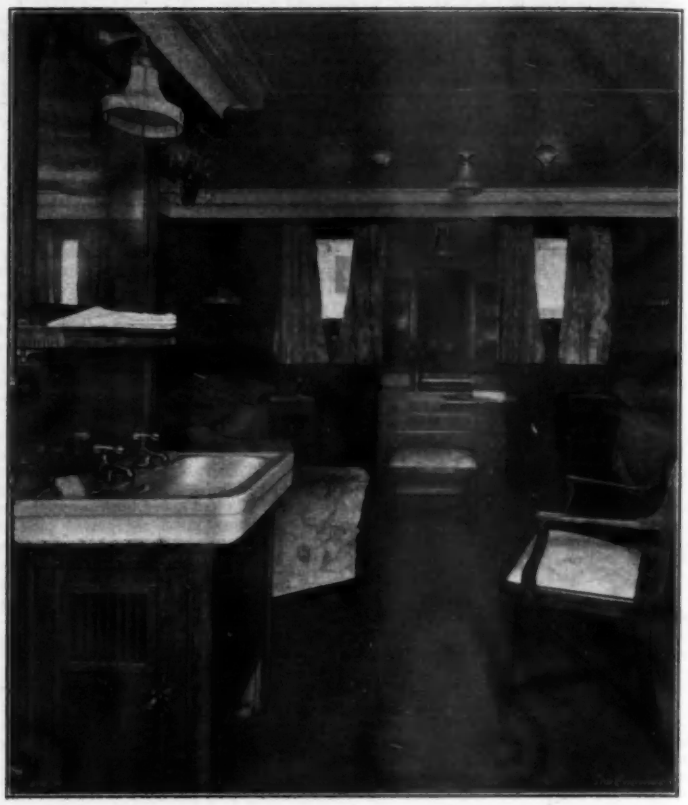

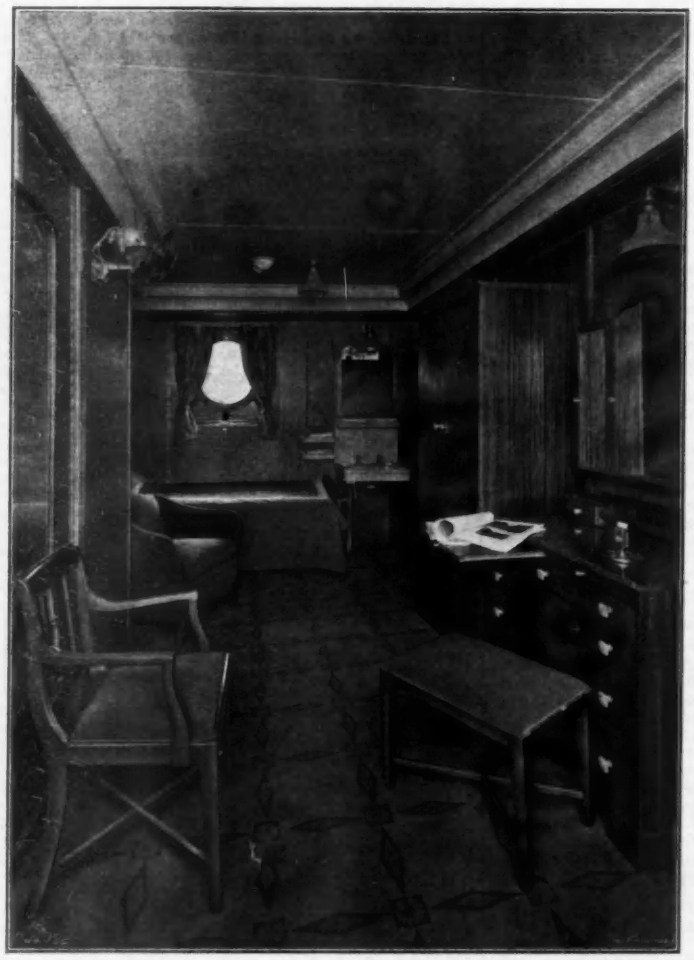

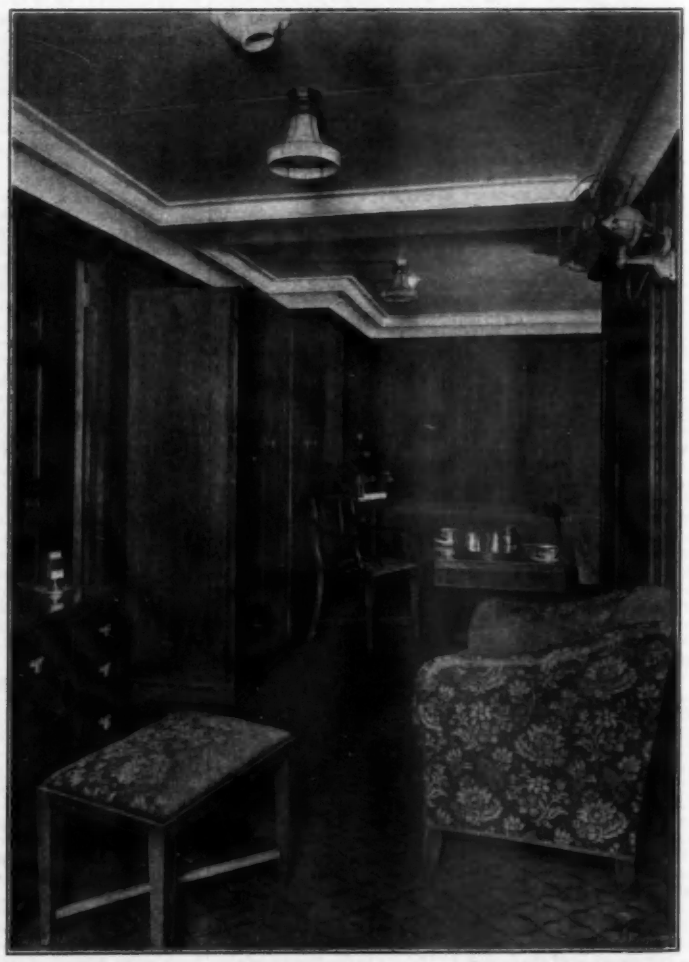

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THE ENGINEER.

VOL. CLI No. 3930

MAY 8, 1931.

Recent Developments in Land Turbines.

IT has been an almost impossible task to keep abreast of the developments in steam turbine practice during the last few years. Progress has been so rapid that the wonder of one day has become the commonplace of the next, only to pass on the morrow along the road to oblivion. We are, however, now approaching conditions beyond which no spectacular advance can be possible, except by reason of some quite unforeseen discovery. There are turbines to-day working at pressures of 2800 lb. per square inch and using steam at temperatures in excess of 450 deg. Cent., a capacity of 200,000 kW has been surpassed in a single generating unit, and there is no scope for any appreciable improvement either in vacuum or in the thermal cycle. Even if, during the next few years, temperatures should be pushed higher by 50 deg. Cent. or so, as they almost certainly will be when the special steels required for the superheater tubes become cheap enough to warrant the step, and supposing, further, that still larger generating units are called for in power stations, the advances on existing practice can only be small in comparison with those which have led to the present position. The time is, therefore, favourable for a general review of the situation, noting the progress so far achieved and appraising the problems yet awaiting a complete solution. For this reason the paper presented by Mr. C. D. Gibb to the Institution of Mechanical Engineers, and reprinted in this and preceding issues, was particularly opportune. The author, with the experience of the first turbine makers in the world to draw upon, and a personal connection with so many of their later achievements, was in an exceptional position to deal with his subject. Nor had the leading foreign builders been backward in supplying information, so that the paper constituted a most valuable record of work accomplished, as well as providing the occasion for an authoritative commentary on the trend of current practice.

Although Mr. Gibb expressly refrained from dealing with the productions of other British makers on the grounds that the report in the "Proceedings" would have greater value if they themselves would contribute details of their own work in the discussion, it will, nevertheless, be seen that this country holds an honourable place in the list of representative machines given in the paper. Indeed, were British manufacturers as keenly alive as some of their foreign competitors to the advantage of keeping their merits continually in the minds of potential customers, they might have had even more opportunities of supplying remarkable machines. They have not yet to their credit any monsters of over 100,000 kW, such as have been installed in America, but it should not be forgotten that C. A. Parsons and Co., Ltd., have twice given a lead to that country on its own ground by the supply of the first 25,000 kW and 50,000 kW units ever built. The same firm has earned for Great Britain the honour of heading the entire world as regards efficiency. The record is held by a machine built for the Dunston station, having the extraordinarily low heat consumption of only 9280 B.Th.U. per kWh. This corresponds to an absolute thermal efficiency of practically 36·8 per cent., a figure which, after allowing for all boiler-room losses, puts steam plant well into rivalry with any internal combustion engine in respect of the conversion of the heat in the fuel into useful work. The turbine capable of such an exceptionally fine performance is a machine of 50,000 kW maximum continuous output working with steam at 600 lb. pressure and a temperature of 800 deg. Fah. at the stop-valve. Its nearest competitor is a somewhat larger unit of the impulse type, constructed by the General Electric Company, with a heat consumption of 9650 B.Th.U. This is closely followed by the 75,000 kW Barking machine of the British Thomson-Houston Company, with a heat consumption of 9850 B.Th.U., referred to by Mr. Samuelson in the discussion. The steam conditions of these three leading machines differ slightly and re-heating is adopted in the case of the two first mentioned; but it may be noticed that all three obtain their efficiencies with the same steam pressure of 600 lb. per square inch. The best figure recorded for really high-pressure machines is a heat consumption of 9900 B.Th.U., attained by two turbines of 125,000 kW and 150,000 kW capacity, respectively, working at a pressure of 1200 lb. This performance, however, is not strictly comparable with those quoted above, since the latter are based on feed-heating conditions. It must also be remembered that until all important tests are certified by some registering authority to have been properly conducted on approved lines, there will always be room for doubts about the value of any comparisons. For this reason, probably, Mr. Gibb laid little stress on the thermodynamic results obtained by modern turbines. He devoted himself rather to the more fruitful fields of manufacture and design, and gave invaluable information as to the present state of the art.

It is really wonderful to reflect how little mechanical difficulty is experienced with modern turbines, in spite of their rapid developments in size, power and blade speed. Bearings, glands, couplings, governor-gear and other details have all met their added responsibilities with comparative ease, and casing troubles are a matter of the past, notwithstanding vastly increased dimensions. Improved design, together with the use of steel in place of cast iron wherever temperatures in excess of 450 deg. Fah. are encountered, have relieved station engineers from anxiety as regards distortion. It is a pity that the opposition of continental turbine makers, referred to by Mr. I. V. Robinson in the discussion, should have prevented the International Turbine Specification from stipulating that steel should be used instead of cast iron under the conditions referred to. Agreement on this matter would have made international competition fairer. It would, moreover, save the less well-informed purchasers from the possibility of certain unhappy experiences. A case in point came under our notice not long ago, the casing of a turbine of continental construction having to be replaced on account of the development of ominous cracks around the steam inlet. The chief anxieties of the turbine designer now appear to be concerned with questions of vibration and of blade deterioration. The former assumes its most troublesome form when it occurs as the axial vibration of the wheels of impulse turbines, and many serious wrecks of such machines can be attributed to this cause. The recent articles in our columns by Mr. R. H. Collingham discussed the question thoroughly and indicated the extreme care taken by the British Thomson-Houston Company to ensure that its machines shall

be immune from all danger of axial vibration. Blade deterioration is common to all types of machine, but is specially liable to occur when the steam velocities are high. It is due mainly to two causes, generally referred to as corrosion and erosion. Wetness of the steam is responsible for both. Corrosion occurs at the point in the turbine where the steam first becomes wet by expansion, the air present with the steam then oxidising the blades. An extremely small amount of air is sufficient for the effect, as is shown by the fact that the corrosion often greatly diminishes or ceases altogether a little further down the machine, although the wetness of the steam has, of course, increased. The only cure is to use blading of non-corrodible metal. For erosion there is no such obvious remedy. The trouble is due to the impact of the blades on the mintue water drops entrained with the steam. The droplets, moving more slowly than the steam, are struck with great violence by the rapidly moving blades, with the result that the leading edges of the latter are first roughened and then destroyed by the formation of tiny crater-like holes covering the whole of the surface affected. No metal suitable for blade manufacture seems capable of resisting the attack. In the case of reaction machines, however, the shape of the blades permits of a strip of erosion-proof metal being brazed along the part exposed to damage without adversely affecting the efficiency of the blading. The impulse machine, unhappily, has no such resource. Reliance has, therefore, to be placed on draining away as much of the water as possible at every stage, a course which has been adopted for several years by all the leading makers. Wet steam in the low-pressure portion of a turbine is one of the greatest of nuisances, and it is to mitigate its effects much more than for any thermodynamic reason that higher and higher initial temperatures are being striven for, and resuperheating is being more frequently employed.

Naval Problems of To-day.

A MOVEMENT has been set on foot to re-establish coal as the principal fuel for British warships. Much as we sympathise with the motives of those who have launched this campaign, we fear they are doomed to disappointment. There is, in our judgment, not the slighest possibility of a reversion to coal for the use of the Navy. In this sphere the advantages of liquid fuel over solid have been thoroughly demonstrated by an experience of nearly twenty years, and by the great majority of naval officers they are acknowledged to be overwhelming. These advantages are both strategic and technical. They are so obvious, and have been so often set forth in the utmost detail in our own columns and elsewhere, that it would be superfluous to recapitulate them now. It is certainly unfortunate that the Navy should be wholly dependent on imported fuel, nearly 70 per cent. of which comes from non-British sources, and every plan for reducing this dependence is deserving of sympathetic consideration. But the proposal to revert to coal must be dismissed as impracticable. Were it to be adopted our warships would become definitely inferior to those of other navies in speed, radius, and general mobility, as also in protection. Coal has ceased to be of interest to the Navy save as a material from which oil may be extracted. Existing methods of extraction are, however, much too expensive to enable the product to compete with imported oil, though research may eventually lead to a more economical process which will remove this disadvantage. We may add that even were it feasible to restore coal to its former supremacy in the Navy, the coal trade would only benefit to the extent of about a million tons a year. The promoters of the "back to coal" campaign seem to forget that the Navy has already shrunk to less than half its pre-war dimensions, and may be still further reduced by international agreement. The decreasing demand for steam coal is due mainly to the increasing use of liquid fuel by the mercantile marine, the Navy being quite a secondary factor in the matter.

It is curious to find in so ardent a naval reformer as Captain Bernard Acworth, R.N., the chief advocate of coal *versus* oil. He deals with this question at considerable length in his recent book, "Navies of To-day and To-morrow," which is, in effect, a penetrating and critical analysis of current naval policy. While unable to accept his views on the fuel problem, we believe many of his criticisms on other aspects of the naval administration to be well warranted and sound. His main thesis concerns the extraordinary complexity and staggering cost of modern naval material. The "Nelson" and "Rodney" are striking examples of this tendency. They are, without doubt, very fine ships, but whether they represent good value for the £15,000,000 which they cost together is at least a debatable point. According to Captain Acworth, they "are a species of craft which, by common consent, will never again be allowed to disfigure the sea. Their dimensions are such as to preclude their employment in parts of the world where docks are not available for their reception. Their mountings are a source of continual anxiety and refit. . . . So concentrated is the fire-control machinery that a single luckily placed shell might well put all nine 16in. guns out of action. Their triple turrets are unsatisfactory. . . . Internally the ships resemble a science museum more closely than a man-of-war, the complication being well-nigh infinite." This is a very serious indictment, coming, as it does, from an experienced naval officer who must be writing from personal knowledge. We, too, when visiting the ships in question, have been amazed at the elaborate, highly intricate, and costly mechanical contrivances which are to be met with everywhere on board. Whatever the other merits of all these devices, they apparently do not conduce to economy of labour, for the ship's company is unusually large—about 1350 officers and men. There are two submerged tubes for firing the 24in. torpedo, the existence of which was until recently an official secret. Why these tubes were installed is a mystery, for one of the positive lessons of the war was the absolute uselessness of a torpedo armament in large ships. Nor can we dissent from Captain Acworth's strictures on the new 10,000-ton cruisers, costing £2,000,000 apiece, packed with machinery and so devoid of armour protection as to be vulnerable to shells of almost any calibre. Why, again, was it considered necessary to spend £1,000,000 on the repair ship "Resource"? Our post-war destroyers are costing about £500,000 each, yet their machinery is alleged to be giving trouble. These craft, it seems to us, are much too large and expensive to be risked for torpedo work, but if that is not their principal *raison d'être*, why are they overburdened with eight tubes? That our latest submarines are indifferently successful is no secret. Captain Acworth, who speaks with all the authority of one who commanded submarines for many years, believes our present building policy in respect of these craft to be retrograde. In the first "L" boats, completed early in the war, we had an excellent all-round type of submarine, of moderate tonnage and cost, which met every reasonable requirement. They could only be improved upon "by simplifying still further their internal mechanism and by doing away with heavy and costly mechanical plant employed to do work that could be more simply and satisfactorily done by hand." Instead of this, later boats have shown a progressive increase in size and internal complexity without any corresponding gain in efficiency. Since the war we have spent untold millions on aircraft carriers, the first cost of which has probably been exceeded by the frequent and extensive refits they have undergone. Can it be pretended that these vast sums of money have been wisely invested? The peculiar disabilities of the aircraft carrier in its present form were dramatically shown on the occasion of H.M.S. "Glorious'" collision with the French liner "Florida" some weeks ago. When the impact occurred most of her machines were in the air, and, owing to damage to the flight deck of the mother ship and the rescue work in which she was engaged, they were unable to return to her. Most of them were fortunate enough to reach land, but two fell into the sea and were lost. This incident has raised fresh doubts as to the practical value of our big carriers, the construction and maintenance of which imposes a very heavy burden on the Navy Estimates. It seems evident, therefore, that the time has come to subject the whole question of naval construction and equipment to a searching inquiry. In view of present conditions, every penny that is voted for the Navy should be laid out to the best advantage. This can be done only by defining the functions of each type of warship, and then planning the smallest and cheapest vessel capable of fulfilling those functions.

Captain Acworth has performed a public service in drawing attention to certain grave shortcomings in naval policy. His criticisms are by no means wholly destructive, for he offers many suggestions which, if acted upon, would, in his judgment, provide us with a thoroughly efficient Fleet at no additional cost. His views on ship design are too revolutionary to command general approval. He would, for example, abolish destroyers and aircraft carriers, leaving only battleships, armoured cruisers and light cruisers. His battleship of the future would be a coal-burning vessel of 12,000 tons, strongly armoured to resist 16in. gunfire, with a maximum speed of 17½ knots, a main armament of six 13·5in. guns—and nothing else. Such a vessel, he considers, could be built for approximately £1,000,000, but we think that if he doubled his estimate he would be nearer the mark. As will be seen, he attaches no value to high speed, but his arguments on this head are not convincing. His case against mounting any medium guns is vitiated by the misstatement that war experience proved the secondary armament of battleships to be useless. It is, on the contrary, an attested fact that the German Battle Fleet on the night of Jutland escaped serious loss mainly by the good use it made of its secondary armaments in repelling the repeated attacks by British destroyers. In general, however, Captain Acworth's suggestions are worthy of serious attention, and we propose to examine them in more detail in a future issue. May we venture to hope that his zeal for naval reform will not be entirely quenched by the inevitable failure of the campaign which is now being waged to reconvert the Fleet to a coal-burning basis?

The Tin-Plate Industry.*

IN tracing the development of the tin-plate trade, one is bound to be impressed by its romance, while one is forced, also, to the realisation that its alternations of progress and set-backs reveal impressively the economic and political upheavals which have taken place in various parts of the world during the last two centuries.

The first great name in the history of the tin-plate industry in this country is that of Andrew Yarranton; it is to him we owe the introduction of the tin-plate trade. He visited Saxony about 1665 to study the process of tin-plate manufacture, and upon his return he appears to have published several tracts, which, at a later date—1677—were published under the title "England's Improvement by Sea and Land." In this work, he states very clearly and forcibly his arguments for the establishment of a tin-plate industry in these islands. But, in the absence of free scope for independent development, nothing further was done until 1720, when John Hanbury, who occupies the second place in historical order among the tin-plate pioneers, permanently established the industry, on a commercial basis, at the Pontypool Ironworks in Monmouthshire.

The advent of coal and its application to the manufacture of iron, the close proximity of the coalfields to the sea, the presence of other metallurgical industries, and the abundant supply of water which was available, gave an impulse to the trade, which, migrating slowly westward, became localised in South Wales. In fact, until about 1890, the manufacture of tin-plates was looked upon as a distinctly Welsh industry; to-day, it is still an integral part of the industrial life of South Wales, and the output of tin-plates is an important index of the activity of a wide range of industries.

In tracing the development of the industry to its present magnitude, there are two distinct and recognised stages. Up to 1880, there followed a continuous series of developments; rolling replaced the method of hammering out plates or sheets as far back as 1728; the grease pot, as a preliminary to the coating process, was introduced in 1745; the introduction of acid as the medium for cleaning plates took place in 1760. When the production of sulphuric acid was cheapened by developments at the local copper works about 1806, acid came into general use for white pickling; in the year 1829 close-annealing was first practised; in 1850 steam was introduced into the pickling vat; the year 1866 saw the introduction of rolls to the tin pots, while labour-saving pickling machines were brought into notice in 1879. I have selected at random some of the most important developments which took place in what I call the first stage of the industry.

The modern phase of the industry dates from 1880, when iron was replaced by steel as the base for tin-plates. The first Siemens steel used for tin-plate-making was actually made in 1875 at Landore, under the direction of Sir William Siemens, with whom my father was associated. About 1880 a number of works were built to manufacture open-hearth steel, and steel bars were substituted, generally, for bars previously made from charcoal iron. It is noteworthy that in 1880 Bessemer steel also replaced puddled iron, which had been commonly used for the cheaper qualities of tin-plate. To-day, as you know, all steel manufactured in this country for tin-plates is made by the open-hearth process.

In the modern phase of the industry, developments were predominantly technical. In 1890 a number of

* Iron and Steel Institute. Presidential address by Colonel Sir W. Charles Wright, Bart., K.B.E., C.B. Abridged.

patent tin pots appeared; cleaning machines came into use about 1892; the year 1900 saw the introduction of the electric crane and the application of individual drives to doublers' shears; another development took place at this time, namely, the arrangement of cold-rolls in tandem formation. I believe that in 1905 a tin-plate mill was electrically driven for the first time. Since that date there have been important developments in the direction of improved mechanisation and layout; reheating and rolling have been subject to considerable research; tunnel-annealing is fast replacing the old methods of annealing, and considerable attention has been given to the problems of improved feeding, cleaning and packing of plates.

It will be obvious that the essential processes of production remain practically what they were in the pre-steel era. On the other hand, largely as a result of the introduction of steel, which made possible larger outputs per mill and gave rise to a demand for thin gauges, there has been a change in the character of the industry, so that to-day production is more technical, labour is more subdivided, demand is more specialised, uses are more exacting, and efficiency is measured in terms of quality and cost. In short, the application of steel to the tin-plate industry is a landmark of real industrial significance.

Let me now direct your attention to some of the special characteristics of the industry. The trade constitutes a valuable export of capital and labour, and the industry has brought our country into commercial relationship with all parts of the world. It relies for approximately 70 per cent. of its total trade upon the export markets, and is, therefore, peculiarly sensitive to any rise or fall in the world's prosperity, and is international in character.

Its position may be characterised as one of unaided competition in an open market. Conversely, in the home market it is not subjected to competition from without, for where the export trade in any commodity is large it is generally found that the percentage of imports is relatively small; in fact, it can be truly said that the Welsh industry has a monopoly of the home market.

Again, the tin-plate industry has been the means of building up specialised local industries. For instance, the steel bar industry of South Wales depends for its existence upon the demand for tin-plates, and it is interesting to contrast the present position with that visualised by Yarranton, who regarded the proposed tin-plate industry as an outlet for the iron industry. In addition to the steel bar trade, there has grown up a number of engineering works and foundries specialising in the requirements of the steel and tin-plate works, which absorb practically the whole of their products. Finally, being at the end of the chain of industries, the tin-plate industry is subject to the cumulative effect of increased costs in the several stages of manufacture preceding it.

Up to 1890 the Welsh industry was without a serious rival and had a virtual monopoly of foreign markets. But in that year came a great change with the passing of the McKinley Tariff Act in 1890. In the decade immediately before the Act of 1890, America had been our chief customer, taking approximately 75 per cent. of our total exports and 60 per cent. of our total production, while in the years 1897 to 1899, when the full effect of the tariff was felt, her imports represented scarcely 23 per cent. of our total exports and only 15 per cent. of our total production. In short, by means of the McKinley tariff, which imposed on tin-plates a duty of almost 60 per cent. of the selling price, America obtained absolute control of her home market, and forced the Welsh industry to change its outlook in regard to the future.

This marked an important stage in the evolution of the tin-plate industry. It was natural that American steel makers, actuated by motives of self-preservation, should have agitated for the imposition of a tariff on tin-plates. There was already in America a substantial market for them; America could not hope at that stage to produce tin-plates at a competitive price; moreover, at that time a serious crisis had developed, following over-production in the American steel industry, which was rapidly expanding. Their effective competition, however, was only temporarily postponed, as with the growth of industry the customers of yesterday were bound to become the producers of to-day. It therefore redounds to the credit of the remnant of Welsh manufacturers who were fortunate to survive at this period, that they applied themselves to the new problems with great activity. The prosperity of the trade was dependent upon the maximum development of exports, and the tin-plate manufacturers gradually secured new export markets in place of the large American market which had, through the operation of a prohibitive tariff, become virtually closed to them.

Just as in 1890 and the succeeding years, tin-plate manufacturers were forced to realise that an extension in the export markets was fundamental to the existence of the industry, so to-day, as a result of the post-war problem of world trade depression, they have been forced to re-examine the position and to realise how essential the development of the home market has become. How far the existence of the tin-plate industry in South Wales is likely to be primarily dependent upon the home market is, of course, a matter for speculation, but it is important to remember that the home demand in America, which has increased enormously since 1890, constitutes the underlying reason for the present existence of the American tin-plate trade.

Mention has been made of the revival in demand subsequent to 1890, but it must not be forgotten that the Welsh industry regained its position as an exporting industry without any great change in the methods of production, the recovery subsequent to the imposition of the McKinley tariff being due largely to the growth in the demand for tin-plates for the canning industries, which were rapidly being developed in Europe and the Colonies. Fortunately for South Wales, no competition was experienced in these new markets for a number of years, so that manufacturers were in a position to set about the rehabilitation of the industry.

I have explained the serious setback experienced as a result of the development of the American industry, while I have also made reference to the subsequent recovery following the opening of new markets overseas. This brings my review of the industry up to the year preceding the war in 1914. Immediately before the war, however, the effect of competition was being increasingly felt, and certain countries had already made successful attempts to manufacture tin-plates. The war precipitated many problems for the industry, and I well remember, when I was at the Ministry of Munitions, how the difficulties of the export trade in tin-plates were intensified by the increasing absorption of steel for the supply of munitions, by a system of enforced restriction of output, and by the acute shortage of labour. While it is true that the exports of tin-plates to certain of our allies were increased, the industry generally was so disorganised that it failed to participate in the increased demand for tin-plates for war purposes. This was again America's opportunity, and she became the premier exporting nation in tin-plates, and benefited to the point of jeopardising our own pre-war supremacy. On the other hand, while the war intensified certain difficulties, it demonstrated to the tin-plate industry, as well as to other sections of the iron and steel industry, the supreme need for organised common effort and a definite trade policy.

There are two distinct phases in the post-war history of the industry. Up to 1921 it seemed to reassert itself, for the demand appeared to exceed the supply. It was, however, very largely a period of replenishment of stocks, but as a result of the general fall in prices, of the reactions of the war, of the instability of exchanges, and of the financial and economic weakness of our overseas customers, the years subsequent to 1921 proved to be, for the tin-plate industry in common with other great exporting industries, a period during which the equilibrium of trade was greatly upset. While it is generally appreciated that the period was partly transitional, what is less generally recognised is the fact that it coincided with a further expansion of capacity and production in such highly industrialised countries as America, Germany, France, and in less industrialised countries, notably India and Japan. It is these developments, which represent a permanent feature, with which the Welsh tin-plate industry will have to reckon in the future. It will be seen, therefore, that the industry is faced with a new set of circumstances. Not only have certain countries which formerly provided good markets for Welsh tin-plates become producers themselves, but some of them have even become competitors in the world markets.

These post-war developments are such that the industry, obviously, cannot afford to be haphazard. Future lines of action must be planned. The whole field of production and distribution must be so explored that the industry may accommodate itself to the changed conditions.

In the first place, a national or trade outlook has already been developed, and the industry has learnt by experience that common action by the industry as a whole can mitigate to a large extent the evils attendant upon a reduction in the demand for its products. At the present time a tin-plate pool is in existence. It has certainly resulted in more stable conditions and prices, and to that extent it has proved beneficial. It is, however, but imperfectly realised by non-members that the pool, as at present constituted, has no degree of permanency. If it is hampered in its operation a reaction must take place, in which event disaster will supervene, for in the present state of the industry solidarity must be maintained at all costs.

I cannot lay too great emphasis on the fact that, while the adjustment of supply to the volume of demand continues to be the most important factor in the trade, the future of the industry, obviously, must depend upon its ability to keep pace with scientific developments. If the industry is to be dynamic, it must continue to pay attention to technical research in all its branches; it cannot afford to be stagnant when the competition of America and other countries shows that we no longer have a monopoly, and that other countries are equally adaptable for this highly specialised trade. In this connection it is interesting to note that as a result of improvements in plant and changes in the manning of plants, the output in 1929, which amounted to 879,844 tons, inclusive of black plate and terne plate, represents the highest attained by the trade, although the industry was working at less than 75 per cent. of its capacity.

Again, the future of the industry is bound up with considerations of orderly marketing. In 1928 the Welsh manufacturers entered into an arrangement with the American tin-plate manufacturers, whereby for a period of years it was agreed that the combined—Welsh and American—exports of tin-plates to certain markets should be distributed between the two countries in a fixed ratio. This imposed a salutary check upon indiscriminate and wasteful competition, and the experience gained has shown us that agreements for orderly marketing, whether national or international in character, can mitigate the difficulties of trading when demand fails to keep pace with productive capacity.

Finally, the problem of expansion is bound up with organised marketing. The present *per capita* consumption of tin-plates in this country is far less than that in America, and, while we can never hope to develop our home consumption to the same extent as America, I feel that the development of home canning will have an important bearing on the future of the tin-plate industry. It may possibly enable plants to run at full capacity, in which event the industry will be able to make profits sufficient to embark upon capital schemes in keeping with modern tendencies and practice. But organised marketing must mean far more than the mere fostering of new markets; it must mean, in the Welsh industry, the creation of new outlets for tin-plates and the sinking of personal rivalries in the desire for a more rational organisation of the industry.

Literature.

A Tribute to Faraday. By ROLLO APPLEYARD. London: Constable and Co., Ltd. 1931. Price 7s. 6d.

WE may expect a flood of literature about Faraday during the next few months. In September, the centenary of his greatest "industrial" discovery will be celebrated, and every newspaper in the land and many authors will desire to say something about the man himself and about induced electric currents. Mr. Appleyard is first in the field, and his book will be consulted by many journalists in search of the human touch which they have rightly been taught to value. It is, indeed, the avowed object of the present author to show the man behind the great discoverer. Whether he wholly succeeds or not it is difficult for us to say. The opinion of someone who knew no more of Faraday than his name would be more useful on that point than ours. To such an one Mr. Appleyard's book may come as a revelation of a very remarkable character; but to anyone who has studied Faraday's diaries, heard lecturers discourse upon his work, read books about him, and, perhaps, talked with those who had actually met him, it may prove a little unsatisfying. To them Faraday already lived. He is not an apotheosized impersonal worker, toiling in the Royal Institution at researches and not caring a penny-piece what anyone did with them, but a human being with like feelings to their own. Even the "Experimental Researches in Electricity," which to some may seem no more than a dull schedule of things attempted, is to them an autobiography. They see Faraday all through the journals, and they share with him his scientific detachment when an experiment fails, and his exuberant joy when one succeeds. When he writes at the end of a brief entry recording the demonstration of a great discovery just the one word "Beautiful," it conveys whole volumes to them.

It is unfortunate that all biographers of the great deem it necessary to record trivialities in order to keep their "subjects" on the plane of common humanity. The Ludwigs and Stracheys may know how to make such trifles luminous, but, in general, no effect is secured by informing the reader that this or that great man did, in his childhood, just the very things that ninety out of every hundred boys do. To tell us that Sir Somebody Something, F.R.S., showed an early proclivity for mechanism by playing with the wheels of his baby chair, or that a great railway magnate once possessed a unique collection of Hornby trains, does not really help us to understand the men at all. Mr. Appleyard has not entirely resisted that tendency, and here and there in his volume one comes across passages which do not achieve their purpose and might have been omitted without loss.

But, taken as a whole, his work is a very readable one, and his selections from the letters and notebooks of Faraday have been well made in view of his declared purpose. We are grateful to him, also, for the reproduction of illustrations which connect us with the period in which the great philosopher worked, amongst which Harriet Moore's paintings of the Royal Institution laboratory in 1852 may be especially mentioned. Much of the happiness in reading a book depends upon the style in which it is produced, and we thank the publishers for giving us a pleasant paper and good type.

It is no easy task to write a good biography of a man like Faraday, and Mr. Appleyard is to be congratulated on the success he has achieved. Faraday embroiled himself in none of the conflicts of the world, he cared nothing for riches, and if he mixed with great artists, scientists and authors, he himself had not the kind of personality that flourishes only in the

"spot-light." Outside his home he lived a simple dual existence; half of it in the laboratory, the other half on the lecture platform. There was nothing intriguing, as we should say nowadays, nothing complex in his "make-up." The Freudian would have been disappointed in him; he was so essentially straightforward and sincere, so absolutely truthful and open with himself and everybody else, so free from any mental twists or peculiarities; in fine, so completely sane, that his life gives the biographer nothing to argue about and offers no episode that creates partisans and few that evoke sentiment. He was a scientist first and last, and, in consequence, there is little of importance that can be said of him beyond a description of the researches to which he devoted himself. About a fighter like Pasteur one can write; one cannot say much about an essentially simple person like Faraday, and it is, perhaps, one of the merits of Mr. Appleyard's book that by its effort to make the most of scanty material it shows us that, after all is said and done, Faraday lived in an atmosphere in which great human biographies are written with difficulty.

Of earlier biographies we should select that written by Tyndall were our first object the "human touch"; "The Life and Letters," by Bence Jones, secretary of the Royal Institution in Faraday's day, is invaluable to historians; Dr. J. H. Gladstone's shorter "Life" is written with precision and a little dryness. These authors were personal friends of Faraday, and one of them—Tyndall—was a master of beautiful English. Possibly, it is because he alone of the three could put into words what they all felt that his volume gives us the best portrait of Faraday. Here are a few sentences almost from the last page of his little book: "He was equally rich in mind and heart. The fairest traits of a character sketched by Paul found in him perfect illustrations. For he was 'blameless, vigilant, sober, of good behaviour, apt to teach, not given to filthy lucre.' He had not a trace of worldly ambition; he declared his duty to his Sovereign by going to the levee once a year, but beyond this he never sought contact with the great. The life of his spirit and of his intellect was so full, that the things which most men strive after were absolutely indifferent to him." . . . "Not half his greatness was incorporate in his science, for science could not reveal the bravery and delicacy of his heart."

After Tyndall we should place Silvanus Thompson. His "Michael Faraday: His Life and Work," published in 1898, is an admirable monograph by "one who never ceases to regret that he never met Faraday." Writing as he did when electrical engineering, founded on Faraday's discoveries, was at length firmly established, Thompson was in a position to appreciate the great pioneer's work even more completely than his contemporaries. A scientist and a researcher himself, every step in Faraday's progress had its proper message for him. Only those who have ploughed the same field know where the boulders lie. Thompson saw the pitfalls and recognised the skill with which Faraday circumnavigated them. His volume, in consequence, lingers upon the researches, and yet, just because he understood the difficulties so well, just because he was one scientist in the same field of knowledge, speaking of another, it is also a very human book; one in which the reader never forgets the man in the scientist.

With Tyndall and Thompson in front of him, Mr. Appleyard had a hard task, and it is to his credit that he has produced a volume which many who already know something of Faraday will read with pleasure, and which will introduce to others one whom the world is the better for remembering.

"Was ever man so simple and so sage,
So crowned and yet so careless of a prize!
Great Faraday who made the world so wise
And loved the labour better than the wage.
* * * * *
"Ah! God, a fitting messenger was he
To show Thy mysteries to us below.
Child as he came has he returned to Thee,
Would he could come but once again to show
The wonder-deep of his simplicity."

—*Cosmo Monkhouse.*

BOOKS RECEIVED.

Electrical Equipment of Automobiles. Second edition. By Dr. S. Parker Smith, D.Sc., &c. London: Chapman and Hall, Ltd., 11, Henrietta-street, W.C. 2. Price 5s. net.

Vertriebshandbuch für Industrielle Betriebe. By Zivil-Ing. J. A. Bader and Dr.-Ing. F. Zeidler. Berlin: V.D.I. Verlag G.m.b.H., Dorotheenstrasse 40, N.W. 7. Price 19·50 marks.

Elements of Mechanism. Fourth edition. By P. Schwamb, A. L. Merrill, and W. H. James. London: Chapman and Hall, Ltd., 11, Henrietta-street, W.C. 2. Price 17s. 6d. net.

Properties and Mechanics of Materials. By P. G. Laurson, M.S., and W. Junkin Cox, C.E. London: Chapman and Hall, Ltd., 11, Henrietta-street, W.C. 2. Price 17s. 6d. net.

The Chemical Engineering and Chemical Catalogue. Seventh edition. Edited by D. M. Nevett, Ph.D., B.Sc., &c. London: Leonard Hill, Ltd., 231–232, Strand, W.C. 2. Price 15s. net.

Investigation of Various Factors Affecting the Heating of Rooms with Direct Steam Radiators. By A. C. Willard, A. P. Kratz, M. K. Fahnestock, and S. Konzo. Urbana, Illinois: The Engineering Experiment Station, University of Illinois, U.S.A. Price 55 cents net.

Post-War Land Turbine Development.*

By C. D. GIBB, B. Eng., Member.

(*Concluded from page 484.*)

SMALL TURBINE PLANTS.

TURBINES with an output of less than, say, 5000 kW, are to-day mostly used for industrial plants in this country, although a considerable number of these small plants are being exported for the supply of power to smaller towns and sparsely populated districts. Recent developments in this class of machine are remarkable for the return to favour of the plant which requires no basement, or, at any rate, only a very small one. This arrangement was frequently adopted as far back as 1900, and has much in its favour. Fig. 18 shows a 1000-kW—economical rating—plant, which has several interesting details of design. The condenser is placed parallel to the turbine and to one side, so that the condenser tubes may be withdrawn into or cleaned from what is necessarily waste space. The overall width of the plant is slightly less than had the condenser been placed under and at right angles to the turbine axis, and by using this arrangement, three machines can be installed in approximately the same area as two of the more common type, since the usual space for withdrawing condenser tubes is no longer required.

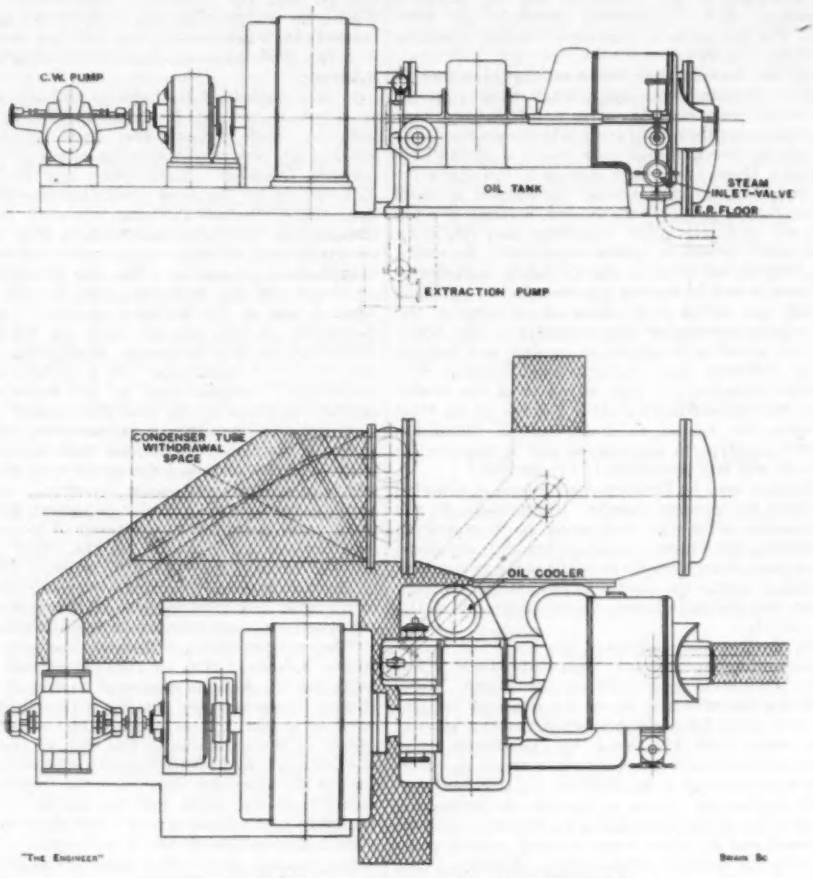


FIG. 18—ARRANGEMENT OF UNIPLANE SET—PARSONS

In the design shown—Fig. 19—the oil tank bed-plate, gear case bottom and cylinder bottom half are in one casing, so that the erection on the site of the turbine and gearing is completed by levelling one casting, no steam-end pedestal beirg necessary. The combined runaway and stop valve, as well as the governor control valves, are accommodated in the cast steel nozzle box, and the whole unit is very compact and accessible. The alternator, exciter, and, if desired, the circulating pump, are mounted on a sole plate set in concrete, and foundation, erection, and building costs are a minimum.

GOVERNING.

The modifications made to governing systems during the past ten years have been in details only for the main part, and little can be added to the excellent descriptions given in Baumann's paper of 1921.* The increase of total steam temperature has introduced some distortion difficulties in the neck glands of the governor valves, but the use of "Perlit" iron here has been quite satisfactory and little trouble is now found.

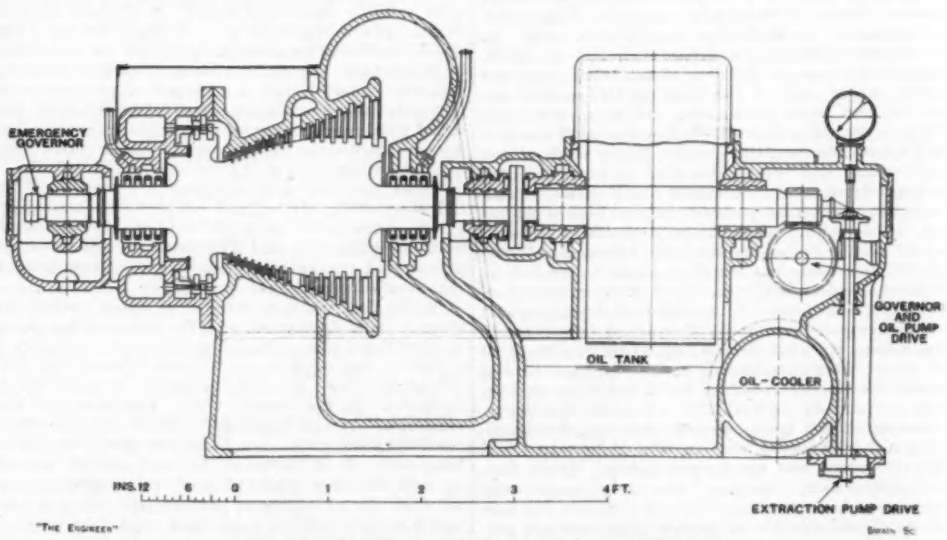


FIG. 19—SECTION THROUGH 1250 KW GEARED UNIPLANE SET

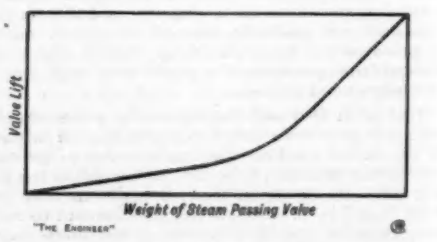


FIG. 20—VALVE LIFT AND WEIGHT OF STEAM

One interesting advance recently made is the variable lever ratio system by which a straight-line governing

* The Institution of Mechanical Engineers, April 17th, 1931.

* *Journal*, I.E.E., 1921, vol. 59.

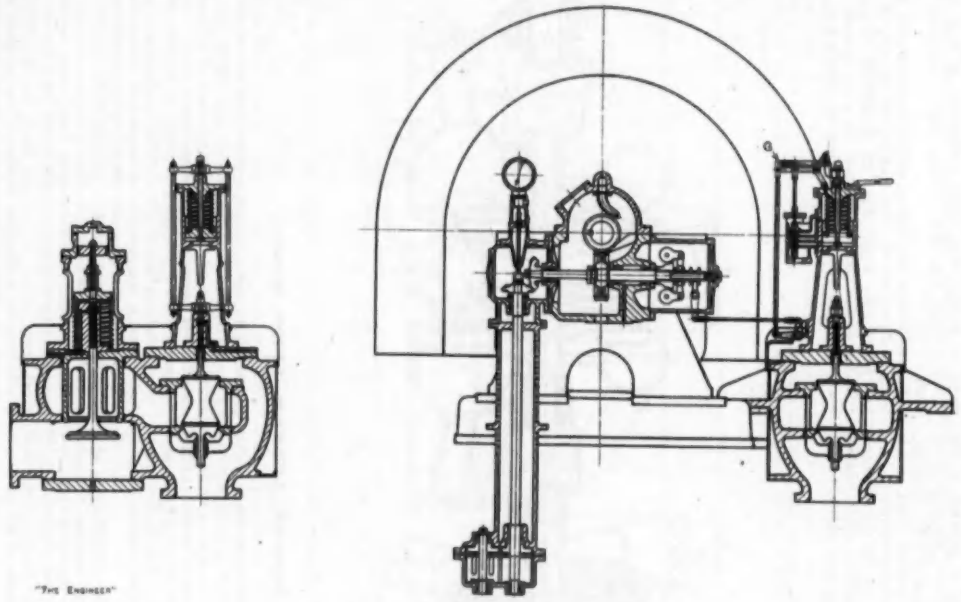


FIG. 21—GOVERNOR WITH TOGGLE MECHANISM

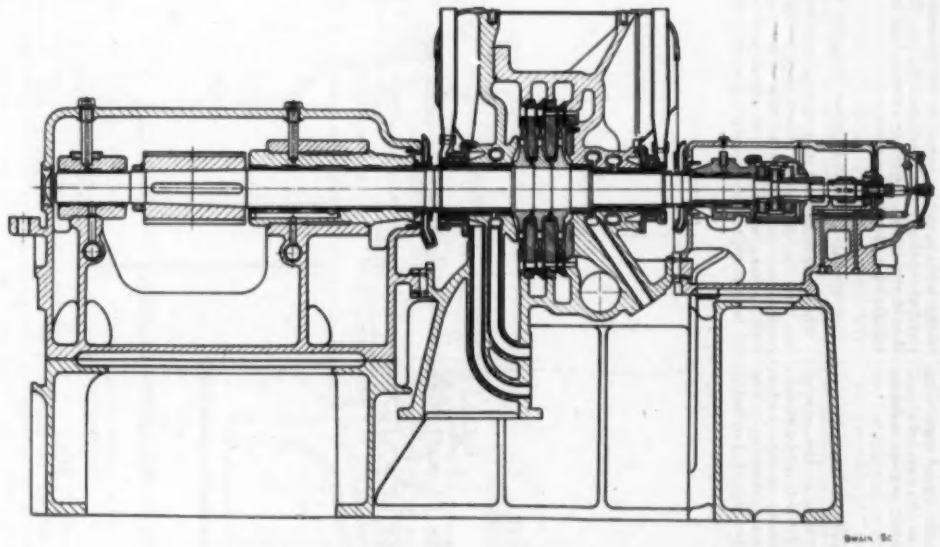


FIG. 22—H.P. CYLINDER OF 8,000-12,000-kW TURBINE—RATEAU

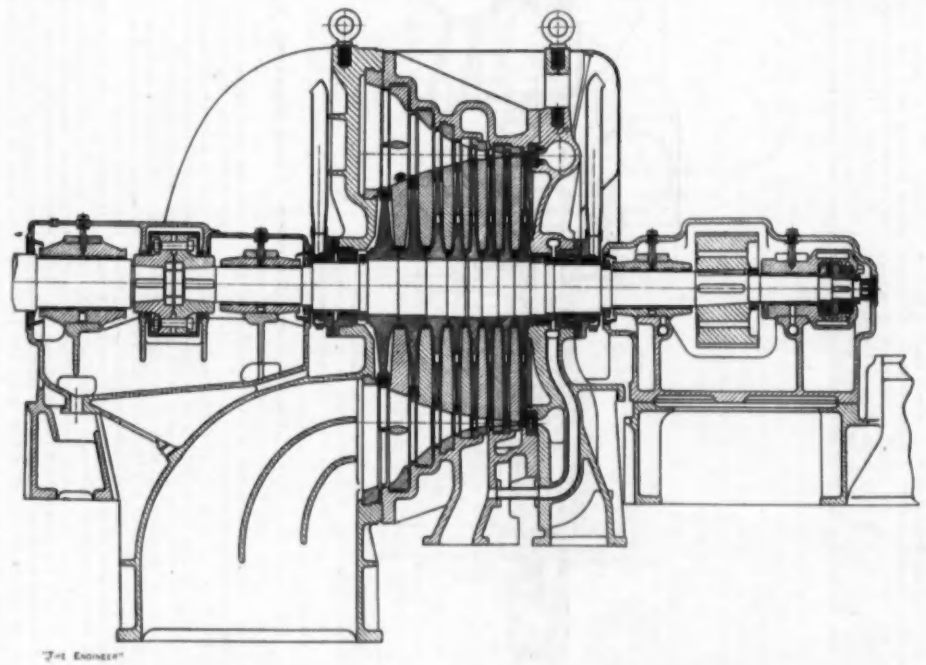


FIG. 23—L.P. CYLINDER OF 8,000-12,000 kW TURBINE-RATEAU

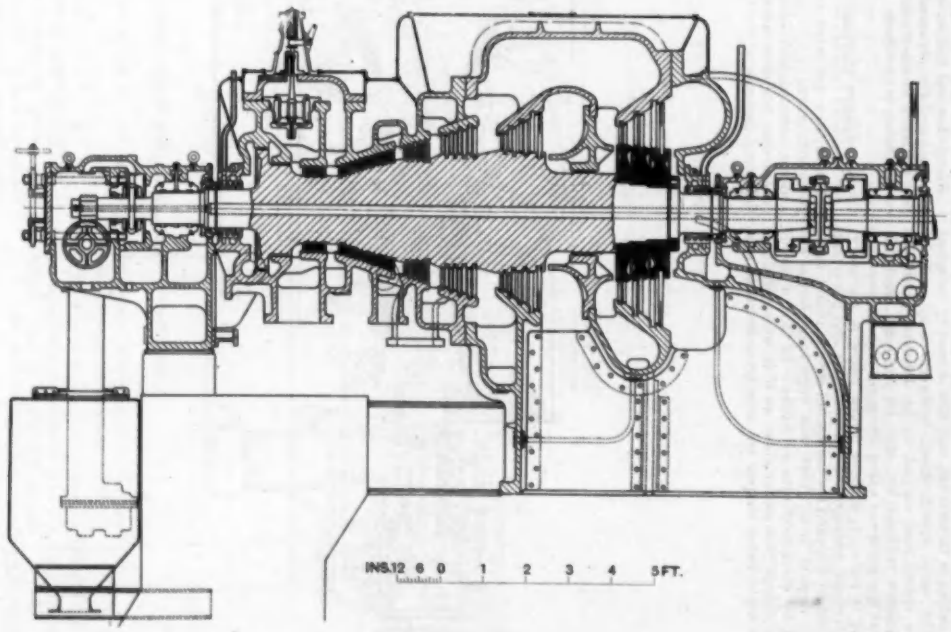


FIG. 24—SINGLE-CYLINDER TURBINE, 15,000 kW—PARSONS

characteristic—i.e., rotational speed plotted against load—is obtained. Turbine specifications usually demand a permanent rise in speed not exceeding 3 per cent. when full-load rating is thrown off, and this is readily complied with. The same specification, however, may call for maximum continuous output to be delivered with the boiler pressure reduced by, say, 10 per cent., and this means that the governor valve lift under normal steaming conditions is reduced, since a larger valve is necessary. With high steam pressures the steam chest and governing valves must be designed for maximum stream lining, since the steam density is so great that very large forces are produced by even moderate velocities; in fact, a useful rule is to design the steam chest as if it were handling water. Simple valve shapes are therefore desirable and a double-plate valve offers the best solution. The steam flow characteristic of this valve, however, is by no means a straight line, and, in fact, is as shown in Fig. 20. Thus, up to approximately half maximum load the governing characteristic is good, but it then rapidly falls off owing to the reduced pressure drop across the valve. The relation between valve lift and governor sleeve movement is normally a straight line, but to obtain straight line governing with a double-plate valve the relation between valve lift and governor movement must be made similar to that between valve lift and weight of steam passed. This can be done very simply by the toggle mechanism shown in Fig. 21, from which it will be seen that as the governor valve opens the point G is moved closer to the relay plunger, thus increasing the lever ratio between governor and oil relay. This mechanism is so proportioned that straight-line governing is obtained.

A simplification of "pass-off" turbines has been effected in recent years by the introduction of a butterfly valve into the cylinder cover, thus doing away with the separate pass-off chest. A longitudinal section through a typical machine is shown in Fig. 25, and the operation is as follows: The connection to the process steam range is made from the high-pressure side of the butterfly valve, and the movement and position of this valve are controlled by an oil-operated servo-motor actuated by the pass-off range pressure. Should the demand for process steam fall while the external load remains constant, the pass-off pressure rises, and by means of the oil relay opens the butterfly valve and passes more steam to the condenser. This in turn produces a small rise in speed, which a sensitive main speed regulating governor checks by reducing the steam inlet pressure, the effect of this being to reduce further the pressure at the pass-off point.

No mechanical link exists between the speed regulating governor and the pressure regulator at the pass-off point, yet, contrary to what might be expected, perfect stability of governing is obtained.

Safety Devices for Reheat Turbines.

Experience indicates that in addition to the normal governor control and overspeed trip fitted to straight condensing turbines, additional precautions are necessary when considering turbines arranged for resuperheating. The following controls or safety devices are regarded as being necessary in this case, and would be fitted on reheat turbines built by the author's firm.

First Line of Defence.—Ordinary high-pressure governor valves controlled by speed which would allow a permanent rise in speed of, say, 3 per cent. when the maximum continuous load is thrown off.

Second Line of Defence.—A steam chest and governor valve placed as close to the turbine as possible in the return pipe line from the reheater to the lower-pressure cylinder. This governor valve is normally fully open, but starts to close at 5 per cent. above normal speed and is fully closed at approximately 6 per cent. overspeed.

Third Line of Defence.—The normal overspeed excentric bolt type governor which trips at 10 per cent. above normal speed and closes the emergency or runaway valve, but at the same time closes the main regulating governor valve mentioned in (1) and the reheat governor valve (2).

Fourth Line of Defence.—A second overspeed excentric bolt type governor mounted in the same housing as the first, but tripping at 12 per cent. above normal speed, and which in addition to doing everything which the first overspeed governor does—if not already done—opens vacuum breaking valves.

Operating conditions at the Barking power station and on the Parsons machine at Crawford-avenue, Chicago, have never demanded the use of these safety devices, but reheat machines in America which did not incorporate them have occasionally given trouble due to overspeeding, and the trend of opinion is definitely in favour of the governor gear outlined above.

A further safeguard fitted to reheat machines is the provision of a pressure relief valve at the point of tap-off to the reheater, and which may have incorporated a pressure-operated plunger which will trip the steam supply to the turbine in the event of the pressure at the tap-off point exceeding a predetermined figure. This is desirable should the reheat governor valves close before the main regulating governor operates.

General Remarks about Modern Machines.

The development of both impulse and reaction turbines has been on extremely sound lines in the period under review, and very large machines of both types have been built, among which may be mentioned the 208,000-kW set for the State Line generating station, Illinois, which is an impulse machine, while Hell Gate station in New York has installed a 160,000 kW pure reaction machine and an impulse-reaction set of similar size.

The Ljüngstrom reaction turbine has been built in sizes up to 30,000 kW.

Ten years ago the impulse machine was almost invariably of shorter overall length than a reaction machine, but there is to-day very little difference, if any, between the floor space occupied by either type of machine in large units.

Fig. 22 shows the high-pressure cylinder of a machine being built by the Société Rateau for an output of 8000 to 12,000 kW, while Fig. 23 shows the low-pressure cylinder of the same machine. It is of interest to note that the high-pressure rotor runs at 7500 r.p.m. and is

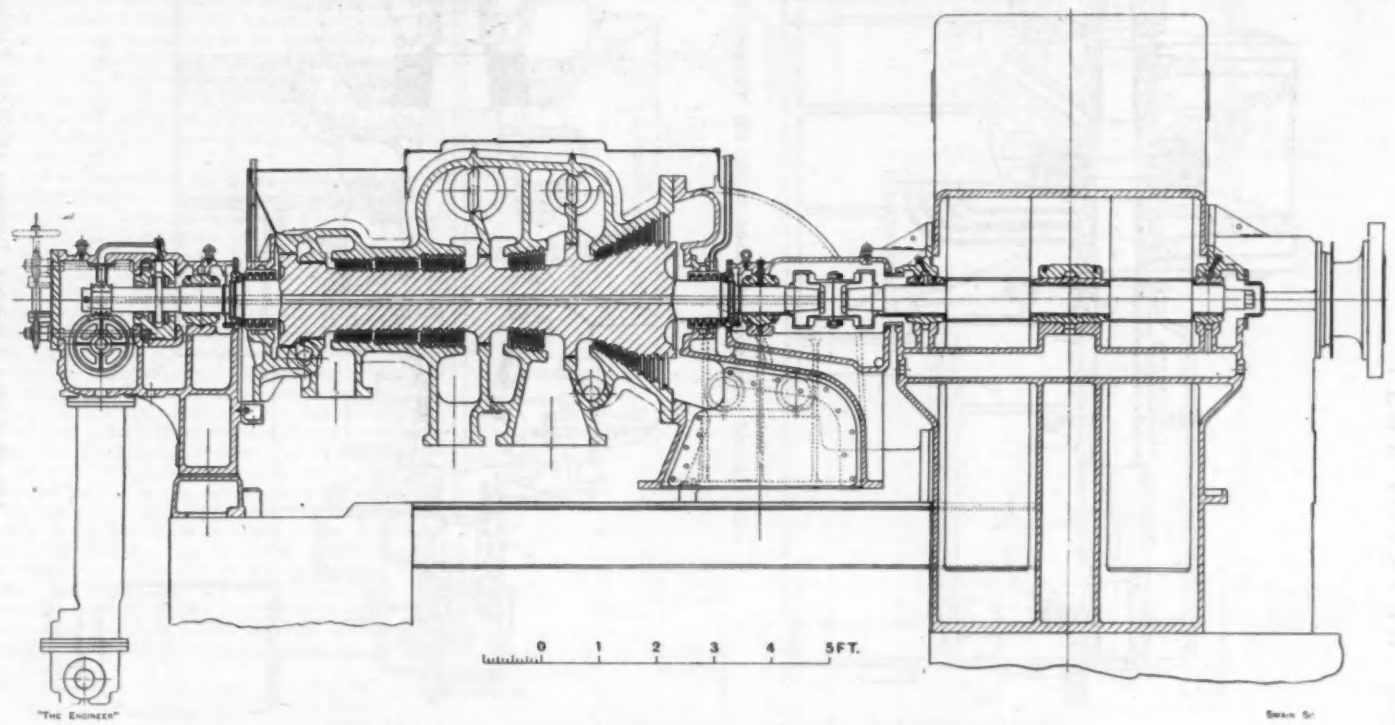


FIG. 25—SECTION THROUGH TURBINE SHOWING BUTTERFLY PASS-OFF VALVES

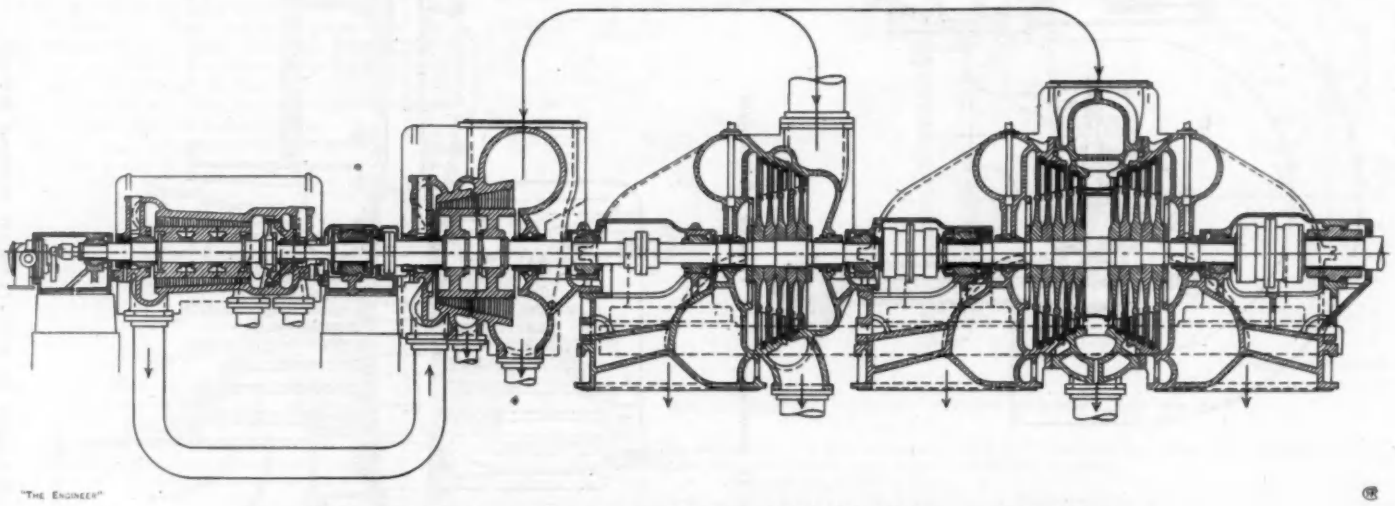


FIG. 26—FOUR-CYLINDER, THREE-EXHAUST TURBINE, 50,000 KW, 3,000 R.P.M.—BROWN BOVERI

geared to the low-pressure spindle, which rotates at 3000 r.p.m. The steaming conditions are 426 lb. per square inch pressure, a total steam temperature of 752 deg. Fah., and 29in. of vacuum (barometer 30in.).

Fig. 24 shows a section through a 15,000 kW, 3600 r.p.m., single-cylinder turbine, which is typical of present-day Parsons single-cylinder machines, where a large output with short overall length is demanded. It will be noticed that a duplex exhaust is provided, as this machine was built for a high vacuum.

Most turbine manufacturers have now adopted the practice of providing a separate bed-plate for the steam-chest, connecting the steam-chest to the cylinder or nozzle-box by a flexible U-pipe. The increase of temperature, coupled with increasing sizes, has demanded this very desirable flexibility.

A noticeable constructional difference between American and continental practice is becoming evident with the extended use of higher steam pressures. American manufacturers appear to be concentrating on two-cylinder machines, which may be of the tandem, or cross-compound type, while several prominent continental firms are adopting three or four-cylinder in-line sets with a single alternator. American practice, however, is generally to increase the steam pressure and to keep the total temperature at 750 deg. Fah., while the more recent continental designs go to 850 deg. Fah. temperature and above in conjunction with higher pressures.

Fig. 26 shows a 50,000 kW, 3000 r.p.m., four-cylinder, three-exhaust turbine at present under construction by Messrs. Brown Boveri and Co., for Saint Denis Power Station, Paris, the initial steam conditions being 767 lb. per square inch pressure at 887 deg. Fah.

The use of several cylinders has much in its favour, as short stiff shafts of relatively low weight tend towards flexibility in operation; but, on the other hand, overall length is increased and interconnecting pipe losses are introduced. The introduction of resuperheating, however, favours the use of a three-cylinder design for outputs approaching the limit at a given speed. Thus, for a 50,000 kW machine at 3000 r.p.m., terminal conditions being 600 lb. per square inch, 800 deg. Fah., and 29in. vacuum, the author's firm would, if reheating were adopted, propose a three-cylinder machine as in Fig. 27.

Turbines are in successful operation in America in which steam is withdrawn from the centre of a cylinder and returned to an adjacent belt after reheating, thus producing a steep temperature gradient in the casting. This would seem to be extremely risky, yet excellent results are, nevertheless, said to be obtained.

A 4000 kW turbine for operating at a pressure of 2810 lb. per square inch has been constructed by Messrs. Brown Boveri and Co. for the Langerbrugge Power Station, and much valuable research work is being carried out, both in England and abroad, with pressures up to the critical, while very large units are operating successfully in America at 1200 lb. per square inch. It is understood that American manufacturers have installed, or have under construction, turbine plant of a total output of over 500,000 kW for operating at pressures of 1200 lb. per square inch or over.

Two 6000 kW geared turbines coupled to D.C. generators and operating at an initial pressure of 600 lb. per square inch and 800 deg. Fah. total temperature, have been in service for approximately four years at the Castner Kellner Alkali Company at Runcorn. No difficulties in operation due either to temperature or pressure have been experienced, and the test results on the turbine plant were quite up to expectations. In fact, the parent company—Imperial Chemical Industries—have since installed plant at other works for much higher pressures.

The adoption of "steeple" compounding, or two-storey turbines for high pressures in order to reduce floor space is of interest, and the International General Electric Company has supplied several plants of this type. The high-pressure cylinder is placed horizontally above the low-pressure cylinder, and although the difficulties of maintenance would appear to be undesirably increased, the reduction in capital charges due to the reduced building size necessary probably compensates for this in special circumstances.

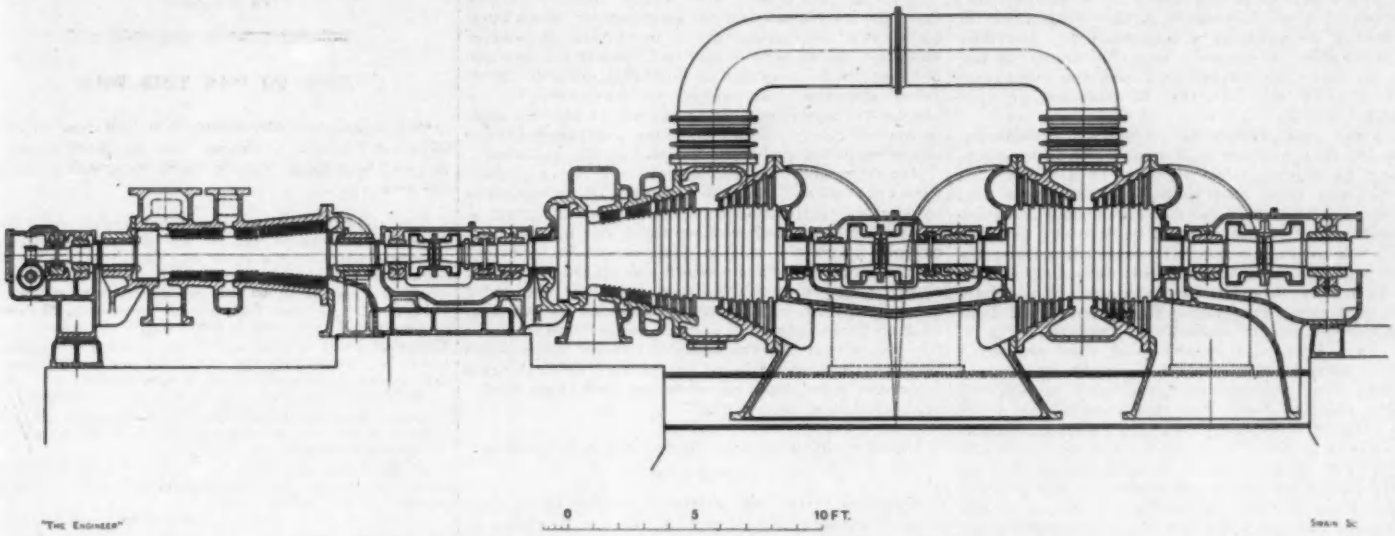


FIG. 27—THREE-CYLINDER TURBINE FOR REHEATING, 50,000 KW, 3,000 R.P.M.—PARSONS

TEST RESULTS.

During an informal discussion at the Institution on the registration of reliable test results on power plant machinery,† Mr. R. H. Parsons pointed out how misleading test results may appear, and after careful consideration the author decided not to publish the test figures so kindly placed at his disposal by many turbine manufacturers, owing to the impossibility of placing them all on a comparable basis.

Variations in turbine efficiency ratio amounting to almost 1 per cent. may be introduced by using different steam tables, while differing methods of calculation also give varying results. That turbine design is now an accurate science may be demonstrated by an analysis of the most recent reliable tests on twenty-five machines of varying size manufactured by the firm with which the author is associated. Out of these twenty-five tests it was found that in nine cases the results were better than those guaranteed, in ten cases the test figures were within 1 per cent. of the guarantees given, and in one only were the test results outside the 2½ per cent. tolerance generally allowed.

As indicating the value of annual tests in maintaining turbine efficiencies, Fig. 28 is reproduced by courtesy of the Newcastle-upon-Tyne Electric Supply Company. This shows how the five machines in the Carville "B" power station have maintained efficiencies better than those guaranteed over a period of many years.

† November 29th, 1929.

The steam consumptions are brought to standard conditions.

Steam pressure = 250 lb. per square inch gauge. Superheat = 300 deg. Fah. Absolute pressure = 1·0in. mercury.

Power factor = 0·75. Load = 10,000 kW.

No.	When put into commission.	Total hours run.									
		1919-20-21.	1922.	1923.	1924.	1925.	1926.	1927.	1928.	1929.	1930.
1	October 3rd, 1916	26,297	—	31,202	38,772	44,610	48,883	55,206	61,305	67,185	74,253
2	April 19th, 1917	12,824	26,825	29,960	37,641	43,685	49,141	54,960	60,120	65,240	71,825
3	June 10th, 1918	14,500	—	26,978	33,469	39,414	44,836	50,413	55,040	60,057	65,936
4	December 5th, 1919 ..	427	—	19,866	27,521	34,292	37,213	43,174	49,006	54,397	61,655
5	May 24th, 1920	400	—	15,960	23,313	27,848	34,071	39,975	44,101	49,567	56,135

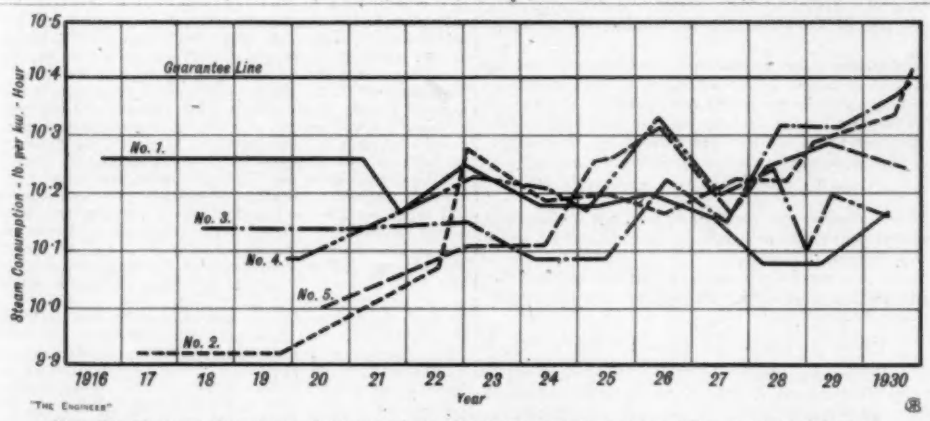


FIG. 28—CURVES SHOWING ANNUAL TEST RESULTS AT CARVILLE "B" POWER STATION

The Corrosion of Iron and Steel.

No. I.

AT the afternoon session yesterday of the Annual Meeting of the Iron and Steel Institute, the first report of the Corrosion Committee was presented. The report is long, and in the main describes methods of experiment rather than results, which in the case of most of the field tests could hardly be expected as yet. The Committee, which has among its members representatives of most of those branches of industry particularly interested in the subject of corrosion, was appointed to investigate:—

(1) The corrosion of ordinary steels, as affected by variations in composition, by methods of manufacture, and by conditions of use.

(2) The corrosion problems arising in steam practice, including high temperatures, as regards superheaters, &c.

(3) Critical consideration of rust-resisting and allied steels.

(4) Any other matters relevant.

The main object of the Committee is therefore to ascertain, both by practical exposure tests and by the investigation of cases in which iron or steel has been found to corrode rapidly, how such corrosion can be reduced to a minimum, either by improving the material itself or by adopting methods of protection. In this way it is hoped to effect material improvements in the corrosion resistance of iron and steel, which will permit of a much more extensive use of these materials in permanent structural work with satisfaction.

Although it is recognised that much work is already being done on the subject of corrosion elsewhere, the Committee in its report states that its work will be found to fit in with the work of others. The problems which the Committee intends to investigate in the early stages are given below:—

(1) The corrosion of ordinary steels, as affected by variations in composition and manufacture. The complete ultimate composition of the ordinary steels is being determined with a view to detecting the influence of extraneous elements, either singly or in conjunction.

(2) As regards steam practice, attempts will be made to elucidate the undoubtedly different response which is at times obtained from boiler plates, as regards resistance to corrosion, when apparently they should behave in the same manner. Possible accelerated effects as regards corrosion due to higher temperatures and pressures will be investigated. The whole question of water treatment with a view to preventing corrosion will be dealt with.

(3) A critical consideration and statement of the properties of the available rust and acid-resisting steels.

(4) To lay down, if possible, agreed corrosion testing conditions that are suitable in the one case for laboratory work, and, in the other, for industrial tests.

(5) To collect information as to the exact position, from the industrial point of view, of the corrosion problem and to record authenticated cases of corrosion.

(6) A study of the character, use, and explanation of the action of restrainers in pickling processes is regarded as within the terms of reference, and is a subject which will be investigated, since it clearly bears upon the phenomenon of corrosion.

The present report is concerned largely with the correlation of existing knowledge of the subject, and in order to get the views of as large a number as possible, a questionnaire was sent out to producers

and consumers of iron and steel, to which a large number of replies were received. These replies indicated in a remarkable way that, normally, ordinary steels, if well cared for, last for very long periods of time.

REPLIES TO THE QUESTIONNAIRE.

The report divides the replies received into four groups, being those from railway companies, shipping companies, engineering firms, and iron and steel manufacturers. The questions asked concerned the length of life of plates, sections or sheets in marine, industrial town, country, sub-tropical, or tropical atmospheres, &c.; the difference in length of life to be expected as a result of different service conditions; the effect of small differences in the composition of the steel or its methods of manufacture; the effect of the addition of copper; and the results of any tests on corrosion carried out, and the conditions believed to be the best for the purposes of such experiments.

In many cases the replies contained definite information on the life of mild steel and iron members as used for the ordinary purposes of industry. In general, they show that there is a very large field in which ordinary steel and iron give excellent service and have as long a life as could be desired; in many cases a steel or iron structure is scrapped, not because it has become unsafe through corrosion, but because the march of progress has rendered it obsolete, either in capacity or design. This is true of all fields of engineering, marine, railway or structural.

Dealing with the question of the protection of the surface, the general opinion appears to be that when properly protected steel or iron will literally last for ever. But there can be no doubt that, where it is necessary to apply a protective coating to iron or steel, any extra time or expense in dealing with the subject is amply repaid by the greatly prolonged life of the material. The practice of bestowing care on the analysis of the metal and leaving the mixing of the paints in unscientific hands is illogical and wasteful.

General opinion seems to favour the view that small differences in the composition of the metal affect the corrosion, but the question as to the effects of differences in manufacture led to inconclusive replies, which may be epitomised by two answers received from railway companies:—

(1) "Cold rolling or working increases corrosion."

(2) "The best results appear to be obtained by finally cold rolling, which has the effect of removing scale."

But as far as annealing is concerned, the balance of opinion seems to be well summed up in the following reply:—

> "Such variations as are experienced are more generally attributable to the type of scale remaining after annealing than to the effect of the annealing process itself."

Opinion generally favours the view that the addition of copper leads to an increase in the resistance to corrosion, the figure recommended ranging from 0·25 to 0·5 per cent., while it seems to be fairly well established that this proportion has no deleterious effect upon the working or mechanical properties of the steel, although some doubt remains as to its effect upon the welding properties.

Very marked interest is shown throughout the industry in the subject of corrosion, many firms being actively engaged upon practical tests, but the methods in use vary considerably. The Committee considers that it may render considerable service to industry by formulating definite proposals for conditions of testing corrosion resistance in the field and in the laboratory, which may result in a standard procedure.

Railway companies are as a whole satisfied with the corrosion-resisting properties of steels, but reference is again made to the waste of money incurred by the use of anti-corrosive coverings if they have to be applied by unskilled labour. The detrimental effect of coal is noted and contact with any moisture is shown, by several examples, to be deleterious. As far as the effect of the use of copper in steel is concerned several railways have tried it, with satisfactory results, while one railway gives figures, reproduced below, to show that the tensile strength appears to be improved by the addition.

Copper, per cent.	Breaking stress, tons per sq. in.	Elastic limit, tons per sq. in.	Reduction of area, per cent.	Extension on 10in., per cent.
Nil	30·1	20·9	44	24
0·23	31·8	21·5	43	25
0·29	31·25	21·2	45	25

These figures are in good agreement with the results of tests by the Committee.

The satisfactory replies received from shipping companies are well summarised by the following quotation from a letter:—

> "As the life of a steel structure of a ship depends entirely on the conditions to which it is subjected and the care exercised in protection by periodic painting or other similar means, I feel that it is impossible to give a definite opinion as to the life of the various parts under different conditions.
>
> "I might say that in our experience the main parts of the structure, *i.e.*, shell plating, frames, beams, casings, &c., with proper care will last as long as the ship—twenty to twenty-five years—and be in sound condition at the end of that time.
>
> "The shell plating, frames, &c., internally, as in cargo holds, passenger accommodation, &c., if kept free from moisture, will remain unaffected at the end of the above periods. Externally where exposed to the action of sea water only, if scraped and painted periodically—three times per annum, as in our case—the deterioration is negligible. The same applies to plates between wind and water and above the water line."

A reply from a firm of structural engineers states that in its experience no structure is abandoned on account of corrosion, but by reason of heavier loading requirements or the fact that it has become obsolete. For coverings of buildings, such as corrugated sheeting, galvanising is considered to be absolutely necessary. It is suggested by the same firm that rollers should consider the possibility of removing mill scale before despatching the material.

Among several points brought out by manufacturers of steel and iron, the resistance of wrought iron to corrosion is mentioned, and examples are given in the report of a number of wrought iron bridges over seventy years old still in good condition. Several makers point out that modern galvanised mild steel sheeting has a much shorter life than the older galvanised iron, but the report includes the warning that no true comparison is made, since there is reason to believe that the thickness of the galvanising has been much reduced in recent years. Several firms have conducted tests on corrosion, and their results are included in the report.

PAPERS, MEMORANDA, RESULTS, AND OTHER INFORMATION.

The Committee states that, contrary to opinion often expressed, a good working theory has been in fact established in a general outline on a reasonably secure experimental basis.

"It has been experimentally demonstrated that iron specimens with clean metallic surfaces, exposed to the atmosphere and certain other oxidising agents, become covered with films of oxide, often invisible. These films appear to be formed by oxidation of the metal *in situ*. They appear to exert an important effect upon the rate and distribution of subsequent electro-chemical corrosion, in spite of the fact that they may never reach sufficient thickness to show interference colours. Under special conditions they may be sufficiently uniform to prevent the attack of certain corrosive agents and so render the metal 'passive'—this is particularly the case with certain alloy steels—but generally in the ordinary steels, the films are not sufficiently uniform and corrosion occurs at those parts of the metal at which the film is porous, cracked, thin, or absent for any reason. Thus an oxide film may be either 'protective' in special conditions, or, more usually, 'directive' only.

"The mechanism of the reaction that results from the presence of a non-uniform oxide film is electro-chemical in character. Experiments have shown that oxide-covered metal is cathodic towards metal free or nearly free from oxide, and that a current is set up when two such samples of metal are plunged in an electrolyte and connected by a wire. The relatively bare metal is attacked and a current flows through the liquid, the film-covered metal forming the positive pole.

"For example, let us consider the electroysis set up when iron is immersed in a sodium choride solution. Ferrous chloride is produced at the attacked portions—the 'anodic' areas—whilst caustic soda and hydrogen are produced at the unattacked, or 'cathodic' areas, in accordance with the following equation:—

$$Fe + 2\,NaCl + 2\,H_2O = FeCl_2 + 2\,NaOH + 2H.$$

"The hydrogen may appear as gas, but if dissolved oxygen is present it will usually be oxidised to water or to hydrogen peroxide.

"Rust is a secondary product, which results from the interaction of the primary products of the electrolysis as follows:—

$$FeCl_2 + 2\,NaOH = Fe(OH)_2 + 2\,NaCl.$$

"The ferrous hydroxide $Fe(OH)_2$ is then oxidised to ferric hydroxide, and sometimes changed to carbonate or other salts under ordinary atmospheric conditions. The mixture of the different iron hydroxides and derived basic salts is commonly known as 'rust.' Some chlorine may often be locked up in the rust, in which case the water becomes slightly alkaline as corrosion proceeds, and there is always local alkalinity at the cathodes."

The Committee believes that corrosion is affected by the method of manufacture; the composition; impurities, segregation, &c.; homogeneity; soundness; general history; the position of the test piece; and the nature of the surface.

In consequence, the complete history of every piece tested is to be put on record.

Owing to the fact that field tests, by which are meant tests out of doors in the atmosphere to which the metal is to be subjected, occupy considerable time, the Committee realises that some sort of acceleration tests are necessary. Such tests may be of great value, but unless scientifically applied they may give misleading results.

According to U. R. Evans, a member of the Committee, "there is nothing essentially unsound in seeking for an accelerated test. But the acceleration must be obtained by intensifying the adverse factors which will be present under service conditions, not by introducing new factors.

One of the goals of a research such as that of the Corrosion Committee is to formulate the correlation between this type of laboratory experiment and the results of field tests, so as to increase the certainty with which it would be possible to predict the results of one from those of the other.

(To be continued.)

HOW TO WIN THIS WAR.

OUR American contemporary, the *Iron Age*, prints the following Editorial in display type on tinted paper. It is signed by John H. Van Deventer, industrial consultant, the *Iron Age*.

Not all wars are announced by formal declaration. America has been at war for the past nineteen months, although many do not know it. The casualties we have suffered in the great economic struggle have been fifteen times as great as those that we experienced overseas in 1917–1918. At least five million Americans have been rendered *hors de combat* in the struggle to make a living. This vast army is now undergoing economic hospitalisation. Dole or no dole, the rest of the nation must pay for taking care of this army of industrial disabled.

In dollars, too, a depression can be as costly as war. The past nineteen months have cost us nearly that many billions in depleted purchasing power. How can we make up for this huge loss?

There is but one way to do it. We must win this economic struggle and then rebuild in the same way that we have always built.

In wars between nations, the victory goes to the one which most effectively designs and uses the improved engines and tools of destruction. Economic wars can be won and rebuilding done only by most effectively using the improved machinery and tools of construction and production.

It is futile to attempt to win this war by lessening the fighting power of our industrial army through wage reductions. That is not the way any wars are won. The thing to do is to give the soldiers better equipment.

Fully half of our 20 billion dollar total of investment in manufacturing machinery and tools is obsolete to-day, regardless of its age. It is obsolete because design, invention, and construction have produced more recent outstanding cost-cutting improvements.

Replacing American industry's obsolete equipment with improved machinery and tools now available is the way to win this economic war and to rebuild prosperity. The resulting cost savings would run into billions, the investment would profitably solve the problem of the plethora of idle funds and reabsorb our surplus of idle labour. An American industry would be placed upon an efficiency level that would assure the continuance of progress for years to come.

And the same strategy that would win this war for the nation, will win it for the individual industrial plant.

THE INSTITUTION OF MUNICIPAL AND COUNTY ENGINEERS.

THE fifty-eighth annual general meeting and conference of the Institution of Municipal and County Engineers will take place at Birmingham between Wednesday, June 17th, and Saturday, June 20th, 1931. On Wednesday the annual general meeting will be held at the Town Hall, Birmingham, at 10 a.m., and in the evening the Lord Mayor and Lady Mayoress of Birmingham will hold a reception in the Council House, Birmingham. On Thursday, June 18th, a conference will be opened in the Town Hall, Birmingham, at 10 a.m., and be continued at 2.15 p.m. The chair will be taken by Mr. Herbert H. Humphries, and an address will be delivered by Mr. R. G. Hetherington, Chief Engineering Inspector, Ministry of Health. A discussion on the following papers will follow:—"The Prevention of River Pollution," by Mr. F. L. Wardman; "Structural Design Examination under Building By-laws," by Mr. H. Ferrington; "The Treatment of Reading Sewage," by Mr. A. S. Parsons; "Recent Sewerage and River Works in Birmingham," by Mr. D. G. Bevan.

On Friday the conference will be continued in the Town Hall at 10 a.m., when three further papers will be discussed: "The Procedure for Establishing Municipal Aerodromes," by Major R. H. S. Mealing; "Town Planning and the New Legislation," by Mr. F. C. Minshull; "Some Modern Mechanical Appliances and their Application to the Requirements of the Public Works Department," by Mr. A. V. Blake. During the meeting visits will be paid to works and places of interest in the neighbourhood.

The annual dinner will be held at the Grand Hotel, Birmingham, on Friday evening.

SECOND INTERNATIONAL CONGRESS OF THE HISTORY OF SCIENCE AND TECHNOLOGY.

THE Congress of the History of Science and Technology originated with the Comité International d'Histoire des Sciences, which was founded at Oslo on August 17th, 1928. This body meets annually in Paris, and organises every three years a Congress in which persons interested in the History of Science and Technology are invited to take part. For the coming Congress the Comité has been fortunate in enlisting the co-operation of its parent body, the Comité International des Sciences Historiques,

together with that of two other international societies, the History of Science Society, Washington, D.C., and the Newcomen Society for the Study of the History of Engineering and Technology, London.

The present Congress, which will be held in London, will comprise morning sessions for papers and discussions, afternoon visits to places of historial and scientific interest, and evening receptions. The inaugural session will be held at 3 p.m. on Monday, June 29th.

It is intended that the papers and discussions at the morning sessions shall centre round the following three themes:—(1) The sciences as an integral part of general historical study; (2) historical and contemporary interrelationship of the physical and biological sciences; (3) inter-dependence of pure and applied science.

Among the receptions that have been arranged are those at the Royal Society, the Royal Society of Medicine, the Royal Institution of Great Britain, the Royal College of Physicians, the Royal Observatory (Greenwich), the Royal Botanic Gardens (Kew), the Science Museum, the Natural History Museum, the National Portrait Gallery, the Institute of Historical Research, Barbers Hall, Down House (Kent.)

Excursions to Oxford and to Cambridge, and a banquet at the May Fair Hotel—tickets 12s. 6d. each—have also been arranged.

A special exhibition of manuscripts and early printed books illustrative of the history of science and technology will be assembled at the British Museum, and will be open to members of the Congress throughout the week, by kind permission of the Librarian.

An exhibition of modern publications on the history of science and technology will be arranged for the Congress at the Science Museum, by kind permission of the Director.

The headquarters will be the Science Museum, South Kensington, S.W. 7. All communications should be addressed to the honorary secretaries at that address. Telephone, Kensington 4310.

B.E.S.A. SPECIFICATIONS.

PIPE FLANGES.

The British Engineering Standards Association has recently published Part 4 of B.S.S. No. 10, Pipe Flanges, which deals with flanges for pressures up to 900 lb. per square inch at a maximum temperature of 800 deg. Fah. With such high temperatures it is necessary to pay special attention to the steel for stud bolts and a specification is given in this connection of a typical steel suitable for the purpose, as a guide to users. The specification, however, allows of the use of any other steel with free cutting properties, which has a resistance to embrittlement greater than that specified. The alloy steel stud bolts are screwed to British Standard fine threads in accordance with B.S.S. No. 191, B.S. Fine Bright Bolts and Nuts, &c., as the additional cross section area obtained with B.S.F. screwing over B.S.W. increases the strength of the bolt by approximately 20 per cent. The dimensions of the flanges have been calculated to give a stiffness value of approximately 40.

ATTACHMENT FOR CIRCULAR SAWS FOR WOODWORKING.

A recent specification issued by the British Engineering Standards Association deals with the attachment of circular saws for woodworking B.S.S. No. 411. It gives dimensions for the diameter of centre hole, diameter of pin and pin-hole, and the distance of the pin from the centre hole for saws of four different ranges of diameter. Tolerances on the more important dimensions are also specified. In fixing these dimensions, the Committee have endeavoured to keep in mind the desirability of accommodating worn saws on smaller machines, and interchangeability can be obtained over quite a wide range of saw diameters.

The specification also includes recommended methods by means of which saws made to the British Standard dimensions may be used on existing saw benches or whereby more than one range of saws can be accommodated on the same machine.

STEEL TUB WHEELS AND AXLES.

The British Engineering Standards Association has just issued a British Standard Specification for Fixed-running and Self-oiling Steel Tub Wheels and Axles for use in Mines.

This specification is based on the replies received to a questionnaire circulated to collieries to ascertain the existing position, which showed that there were over 3000 types and sizes in use. These have been reduced in the present specification to 25. The replies received showed that fixed running wheels were used in 90 per cent. of the tubs in use, while of the other types 82 per cent. were of the self-oiling type. These two types have, therefore, been provided for in the specification, there being 17 fixed-running wheels ranging in size from 8in. to 15in., and eight self-oiling wheels ranging in size from 10in. to 17in. The replies to the questionnaire also showed that curved spokes were used in 80 per cent. of the wheels in use, and as this type of wheel facilitates casting it has been adopted.

The wheels have been standardised for use with axles with round ends, but, in order to provide for the practice in certain of the coalfields, provision is made for these to be varied to permit of the use of axles with square ends.

Sixty-two per cent. of the wheels used were found to be made of cast steel and 36 per cent. of manganese steel. Alternative specifications for these materials have, therefore, been included. A specification has also been included for the steel for use for the axles.

Copies of any of these specifications may be obtained from the British Engineering Standards Association, Publications Department, 28, Victoria-street, S.W. 1, price 2s. 2d., each, post free.

Provincial Letters.

THE MIDLANDS AND STAFFORDSHIRE.

(From our own Correspondent.)

Trade Position Unchanged.

In Midland and Staffordshire iron and steel and heavy engineering industries there has been no improvement worthy of note on the week. The basic trades of this important area continue under a cloud which shows no sign of rapidly passing away. Returning activity in seasonal trades is making some impression on the lighter manufacturing works, but even in such cases as automobile manufacture demand for iron and steel is below that usual at this time of the year. Little business has been transacted on the Birmingham Exchange this week, and attendance at the weekly meeting was slight. Industrialists in this district, believing that the bottom of the depression has been reached, are hoping soon to see an upward trend in trade. Though present evidences are not elating, and although previous expectations have many times been disappointed, a mild optimism predominates industrial circles.

Pig Iron Prices.

As anticipated in my last week's letter, Midland producers of pig iron have not seen fit to make any alteration in selling rates. At the monthly meeting of the Central Pig Iron Producers' Association prices were reaffirmed for a further month. Northamptonshire forge is £3 2s. 6d.; No. 1 foundry, £3 10s. 6d.; No. 2, £3 9s. 6d.; No. 3, £3 7s. 6d.; No. 4, £3 6s. 6d. Derbyshire and North Staffordshire forge iron is £3 6s.; No. 1 foundry, £3 14s.; No. 2, £3 13s.; No. 3, £3 11s.; and No. 4, £3 10s.—all delivered at stations in the Black Country and subject to rebate to those consumers who have pledged themselves to use only British material. Pig iron consumers are dissatisfied with the system of rigid price control exercised by the smelters, and under present circumstances they refuse to contract for supplies ahead of immediate requirements. Their orders are confined to small tonnages required for immediate working up. Reports are current this week of a slight expansion of activity at some of the local foundries, but they appear to refer only to isolated cases. The general business tone, alike at the foundries and forges in the Black Country, shows no improvement. Demand for iron, poor as it is, is almost up to the level of production, and blast-furnacemen assert that there is no serious augmentation of stocks. Supplies, however, are plentiful, and users experience no difficulty in getting quick, if not immediate, delivery. Blast-furnace coke is in ample supply, values keeping steady.

Finished Iron.

The recent reductions in finished iron prices in this area have had little effect upon sales, and Staffordshire iron masters still find difficulty in keeping plants operating. Although some general engineering firms are reasonably active, their immediate iron requirements are not large, and uncertainty as to the future causes reluctance to contract forward. Best quality marked bars sell at £12 per ton at makers' works, while Crown quality bars vary considerably in price. Some supplies have this week been offered at £9 10s., but in other quarters even £10 would not be entertained by sellers. Makers of Crown iron in other districts are still seeking for business in this area, and it is reported that selling prices depend a good deal upon the nature of the order under discussion. A figure in the neighbourhood of £9 5s. is probably the market level for this class of material. Common bars for the bolt and nut and fencing trades are in very poor request, despite the low quotation of £8 12s. 6d. per ton. With trade as it is to-day, users have recourse to the very much cheaper material offered by Belgian ironmasters. In the strip department activity is sustained at late levels. The recent improvement in demand has made no further headway. Values remain at £10 7s. 6d. per ton.

Steel.

Steel masters in the Midlands are unable to verify the reports of a betterment of prospects in the trade. Demand, they say, does not grow at all, practically all the large consuming works being only thinly employed. Moreover, they fail to perceive any definite evidences of improvement coming about during the next few weeks. Structural engineers hereabouts are consuming but small quantities of steel, and some of the largest firms are only able to specify small tonnages. There is no easing of the frequent roll changing position at the steel mills, a great variety of sizes being included in the small orders which are received. Prices of heavy steel are unchanged. Angles command £8 7s. 6d. and tees £9 7s. 6d., both less 15s. rebate, while joists make £8 15s., less 22s. 6d. rebate. Ship, bridge, and tank plates are £8 17s. 6d., with a 15s. rebate. Plate works are slightly worse off for orders, and boiler plates now vary in price from £9 to £9 2s. 6d. per ton. In the market for semi-finished material transactions are too insignificant to afford a test of values. Soft billets are quoted £5 5s., and small bars £7, but it is surmised that these prices would be shaded by sellers if there was a chance of substantial business being secured. Staffordshire hoops are named £9 10s. per ton at makers' works. Continental competition in half-products remains keen, though the price position is a little more stable. Quotations are not materially changed. Birmingham merchants say that there is very little business being done at present.

Galvanised Sheets.

The galvanised sheet market in the Midlands continues quiet. The increasing inquiries from overseas regarding supplies have not yet developed into concrete business. Some small-scale orders are on makers' books, and these enable mills to continue rolling with fair regularity. South America is likely to prove the best potential market in the near future. Values remain unaltered on the basis of £11 per ton f.o.b. for 24-gauge galvanised corrugated sheets. Demand in other branches of the trade is just about upheld at recent levels.

Industries Fair Buildings.

Owing to the continued growth of the heavy section of the British Industries Fair, further extensions of the buildings to house the exhibits at Castle Bromwich, Birmingham, have become necessary. Each year since the Fair was started, extensions have had to be made, and on each occasion they have proved inadequate to permit of all intending exhibitors getting the space they desired. It is now proposed that the land and buildings should be acquired by the Birmingham Corporation at a cost of £31,780. The Chamber of Commerce, which is responsible for the Fair in Birmingham, desires a lease for a period which will justify the expenditure. The Tame and Rea Drainage Board, to which the land and buildings at present belong, is prevented by statutes from granting anything but a short lease. The difficulty can be overcome if the property—47 acres in extent—is bought by the Corporation.

Midland Coal Prices Advanced.

As a result of a meeting of the Midland District Coal Mines Board, the various collieries were informed on Thursday last that it had been decided to increase by amounts ranging up to 2s. 6d. a ton the price of gas coal, public utility coal, industrial, and house coal. The various advances are as follows:—Gas and public utility coal, up to 2s. 6d. on recommended prices; house coal, 1s. a ton on minimum prices; industrial coal, 2s. a ton. The advances came into force on Friday last.

An Electrical Order.

The General Electric Company, Ltd., of Witton Works, Birmingham, has received from the London, Midland and Scottish Railway Company an order for two 1200-kW remote-controlled mercury arc rectifiers, with starting gear, for installation in the Upney-lane substation of the Barking–Upminster electrification scheme.

Unemployment.

The improvement in the employment position in the Midlands area noted last week has not been maintained, and the decrease of 12,459 has been lessened by 5596. The latest returns show the number of wholly unemployed to be 241,247, against 240,870 in the previous week, temporarily stopped 124,087, against 118,825; normally in casual employment, 515, against 558; making a total of 365,849, against 360,253. It will be observed that the chief increase refers to workers temporarily stopped, but as the period of suspension varies, and in many cases is unknown, it is evident that the works are really very short of orders. Birmingham, fortunately, is relatively favourably placed, there having been a decrease in this area on the week of 1111. The present figure, however, is 37,505 higher than in the corresponding week last year.

LANCASHIRE.

(From our own Correspondents.)

MANCHESTER.

Roads and Bridges.

Road and bridge schemes are occupying an important place at the present time in the deliberations of the City Councils of both Manchester and Salford. The Manchester schemes largely affect certain Cheshire areas which have recently come within the city boundaries, and have, consequently, been the subject of negotiations between the Manchester Town Planning Committee and Cheshire County Council. The cost is estimated at £221,797, of which Ministry of Transport grants will account for £131,417. The Finance Committee of Manchester City Council has also prepared a supplementary estimate for £13,000 for the purpose of carrying out extensions to the river wall and strengthening the structure of the approach at the Regent-road entrance to the Water-street depôt of the Cleansing Committee. Salford Building and Bridges Committee proposes to rebuild Trafford Bridge, a swing bridge crossing the Manchester Ship Canal, at a cost of £36,000. The bridge was first opened to traffic a little over fifty years ago, and is described by the chairman of the Committee as being in a dangerous condition.

Money for Electricity Extensions.

Permission to apply to the Electricity Commissioners for power to borrow the sum of £90,000 for supply extensions is sought by Manchester Corporation Electricity Committee, the purpose being to lay additional feeder cables between the power station at Barton and Manchester. Mr. H. C. Lamb, the city's chief electrical engineer, in a report on the matter, points out that the cost of one feeder is estimated at £38,750, but that, in the course of a year or two, it will be necessary to open the ground for another feeder which would entail an additional cost of £56,100. A saving in capital cost of £6500 would be effected if the two cables were laid at the same time, and this is the course favoured by the Electricity Committee.

Everton Tunnel Difficulties.

A hitch is reported to have occurred in the negotiations between the Liverpool Corporation Finance Committee and the Ministry of Transport regarding the proposed construction of a tunnel in the Everton district of Liverpool. The cost of the scheme was expected to be in the neighbourhood of £2,000,000, and it is understood that the Finance Committee has been informed by the Ministry that at the moment it is not prepared to commit itself to a grant and that even under the most favourable circumstances a grant would not exceed 60 per cent. of the total cost. Apparently, the Liverpool Finance Committee was basing its plans on a Ministry grant of 75 per cent.

Non-ferrous Metals.

It is logical to assume that at some undeterminable point non-ferrous metal prices will really touch rock bottom, but, in the meantime, the continued weakness is further destructive of confidence. Improvement at the industrial end would naturally go far to solve the problem, but of this there is no sign and the past week has witnessed a fall, which, except for spelter, has been serious in all sections, new low records having been set up. In the case of copper, the fresh decline has attracted some attention from users, but purely speculative transactions have contributed in no small measure to the week's heavy turnover. The fact is, of course, that the statistical position, as in the other sections of the market, is distinctly bearish, and a net loss on balance for the week of roughly £1 15s. has been entailed in standard brands. Excessive supplies are also pressing heavily on the market for tin, and prices have suffered to the extent of between £3 and £4, bringing current quotations down to almost exactly £20 below what they were about the middle of March, which represented the peak of the previous recovery. Sales of spelter have been extremely poor, but in this section the fall has amounted to little more than a shilling a ton compared with a week ago. All the same, the price at the moment of writing is the lowest in the history of the metal. A further heavy decline in lead of 10s. completes the dismal story of the week. Here, also, the demand for industrial consumption is on an extremely small scale, and, for the time being, no marked return to steadier conditions is anticipated.

Iron and Steel.

There has been a disappointing absence of improvement on the iron and steel markets here. Pig iron users in Lancashire have failed to display the customary monthly buying interest and little expansion in the demand has been experienced by Midland makers, the abundance of cheap machinery scrap continuing to restrict the outlet for foundry iron. For delivery to works in the Manchester district, Staffordshire, Derbyshire and North-East Coast makes are all quoted at 69s. 6d. per ton, Northampton at 68s., Scottish at about 88s. 6d., and West Coast hematite at 82s. 6d. Bar iron makers in Lancashire are poorly engaged and transactions this week have amounted to a very small tonnage in the aggregate. Crown quality bars are quoted at £10 5s. per ton and seconds at £8 15s. Sales of special steels are of moderate extent, but, here again, individual orders are for limited quantities. Business in heavy steels leaves a good deal to be desired and rollers are getting relatively little support just now from Lancashire users, most of whom are working at much below capacity. Weakness continues to be displayed in re-rolled bars, and although £6 15s. per ton is still being quoted for the small sizes, this figure would probably be shaded. Boiler plates are also easy in tendency at about £9, with other prices held at £8 15s. for joists, £8 7s. 6d. for sections, £8 17s. 6d. for general plates, and £9 7s. 6d. for large diameter bars. Marked declines have taken place in continental steel prices here, but buying interest in this section is no greater than before. For delivery in the Manchester area, imported wire rods are at £6 5s. per ton for Siemens and £5 12s. 6d. for Thomas, joists at £4 11s. 6d., angles at £4 17s. 6d., Thomas plates at £5 12s. 6d., billets at about £4, and sheet bars at £4 2s. 6d.

BARROW-IN-FURNESS.

Hematite.

Business is quieter, generally speaking, and the local demand is reduced in some districts. A month or two ago there was a hope that a better market might develop, and certainly there were some signs of bigger demands on the part of consumers. Still, there was one important factor which was lacking, and that was a desire on the part of buyers to place orders for forward delivery. This would have been a sign of greater confidence as to the future amongst buyers. Customers preferred the hand-to-mouth policy, merely buying the pig iron sufficient for the present, knowing full well that there were plenty of stocks to go at should their requirements increase, and perhaps hoping in the meantime for an easing off in price. Stocks of pig iron there are now in plenty, and they probably total over 100,000 tons. Now, with less iron being required on steel account, stocks may increase. No branch of trade is bright, either home, continental or American, and it is possible that outputs will be reduced. Iron ore is quiet, and will continue to be so until more furnaces go in in this district, and there is greater activity in the Midlands and Scotland. Steel is very dull indeed. The rail mills at Barrow laid off last week-end, and it is not known when they will restart. The mills at Workington are engaged and there are sufficient contracts to keep them going for about two months, but not at full output. The hoop mills at Barrow continue, of course, for the demand for this class of steel still shows some life.

SHEFFIELD.

(From our own Correspondent.)

The Downward Trend.

IT is still impossible to find any indication of improvement in the local steel trade. On the contrary, the downward tendency which has been in evidence far too long is growing more marked, and is affecting an increasing number of departments. The depression is particularly noticeable in regard to heavy steel. A statement recently published as to steel production shows that Sheffield's total in 1930 was only 968,000 tons, as compared with 1,217,000 tons in 1929. The tonnage being turned out at present is probably about the same as before the Easter stoppage, and most of the men who were suspended for that period have now been able to resume work. There is, however, no promise in the situation. Substantial inquiries, such as would suggest increased business in the near future, are lacking, and the orders being booked for billets and rolled material hardly provide an outlet for the limited amount of plant that is working. Consumption of basic scrap is at the lowest level known for many years, and business is severely restricted. The depression in the pig iron market is unrelieved.

Various Departments.

Not since the war has the demand for ship-building steel been so poor as it is at present. The reduction in the amount of freights carried, both outward and inward, has thrown many ships idle, and owners have no inducement to build new tonnage. A similar state of things applies to railway steel. The fall in traffics means lessened wear and tear of stock, and consequently the companies have few orders to give out for axles, tires, and springs. The building of wagons for private owners is almost at a standstill. There are no important contracts on hand at the heavy engineering works. One local firm has just failed to secure a contract for a large iron and steel plant for Soviet Russia, which would have provided several months' work for a considerable number of men, and represented an important amount of money. The negotiations, which had appeared to be proceeding well, have fallen through, probably owing to credit difficulties, and it is believed that the work will be placed on the Continent. In a number of departments there are numerous orders which, however, are individually small, and which, while providing plenty of work for clerical staffs, yield little or no profit. Stainless steel and kindred materials maintain their position as a branch of trade enjoying considerable activity, but there is no expansion to report. Demands from the automobile builders also keep up fairly well, especially in relation to heavy commercial vehicles, but the volume of work is not equal to that of a year or two ago. While no changes in the controlled prices of steel are announced, there is much under-quoting for materials on the open market. This is most pronounced in the case of alloys used in the making of special steels. The market for these alloying metals continues to decline, and forward buying is almost non-existent. The home market is taking moderate quantities of tool steels and also manufactured tools, but the export trade, in these, as in several other branches, has fallen to a very low ebb. The exports of steel from Sheffield to the United States during the quarter ended March 31st reached a value of only £16,500, as compared with £28,000 in the corresponding period of 1930.

Cutlery and Plate.

The home demand for these goods is still severely restricted, and even the leading firms are being seriously hit, while all are working much below capacity. Orders from catering firms and shipowners are much below the average, and there is a heavy fall in the coupon and cheap bazaar trade in comparison with a year ago. The demand for ivory handled cutlery continues on a very limited scale, and the trade in best pen and pocket knives, although fairly steady, is not of large volume. The safety razor trade fails to maintain its former activity, and only two or three firms have a satisfactory amount of work on hand. The depressed state of the Australasian markets is a leading factor in bringing about the present state of things in Sheffield. Financial conditions in the Commonwealth show no improvement, and trade is heavily down, while there is nothing much better to report of New Zealand, which has long held the position of Sheffield's best customer for cutlery and plant in relation to population. The last quarter's returns of exports to the United States show that trade has fallen to hardly recognisable proportions, the figure being only £2170 as against £33,000 in the first quarter of 1930. There were heavy declines in safety razors, blades, and blanks. Down to nine months ago a Sheffield firm was supplying the principal razor house in the United States with safety blade blanks, but this trade has now ceased. Some hopes of an improvement in the home trade are encouraged by the extension of the supply of cutlery on the hire purchase system. It is announced that one London firm has bought a large stock of canteens of Sheffield cutlery, which it is selling on the easy payment principle. Twelve monthly payments will secure anything from a small canteen costing £5 to a walnut cabinet canteen with 134 pieces of cutlery and a cocktail cabinet costing £75. A salesman of the firm states that, although the market for expensive cutlery has not been large of recent years, they find that there is a big public anxious for cutlery if it can be bought out of income. He reports that the firm has done very good business under the new system.

A Drop in Turnover.

The extent to which the recent wave of trade depression has affected Sheffield was indicated at the annual meeting of Sanderson Brothers and Newbould, Ltd., to whose heavy loss I referred last week. The chairman stated that the company's turnover in 1930 was £376,382, as compared with £457,754 in 1929. The first six months' trading was practically equal to that of the corresponding period. Of the total decrease of £81,372, no less than £72,730 was attributable to the last six months.

NORTH OF ENGLAND.

(From our own Correspondent.)

Contracts from Russia.

ASHMORE, BENSON, PEASE AND CO., LTD., of Stockton-on-Tees, have received from the Union of Soviet Socialist Republics important orders in connection with blast-furnace plant, including two pig-casting machines of the double-strand type. The firm is the sole British licensee for these pig-casting machines, which they build to the design of the Pittsburgh Coal Washer Company. The production of pig iron by these machines, which cast the hot metal into pigs of suitable size, is an essential practice with modern large production blast-furnaces, and has displaced entirely the old sand-beds. The whole of the material for the machines will be made in this country. They are to be installed on the blast-furnace plants at Kuznetsk and Magnitokorski, the erection and actual starting up of the machines being under the supervision of Ashmore, Benson, Pease and Co., Ltd. For the same clients the firm has an order for four automatic hot-blast, temperature-control outfits for regulating the temperature of the hot blast to the furnaces at Kuznetsk and Magnitokoski.

Iron and Steel Exports Improve.

A slight recovery in the iron and steel export trade of Cleveland, as indicated by the returns for the month of April, is a hopeful sign. The exports, coastwise and foreign, reached 56,370 tons, which is the highest figure recorded for a period of six months. The monthly totals for the four months of 1931 have been: January, 46,056 tons; February, 42,737 tons; March, 51,380 tons; April, 56,370 tons. Pig iron shipments in April aggregating 10,552 tons, are 3294 tons in excess of the March total, but fall short of the January and February figures, which were, respectively, 14,222 tons and 11,380 tons. On the other hand, manufactured iron and steel shipments reached 45,818 tons, which exceeds any previous month's total since August last. The increased steel shipments were entirely owing to heavy despatches of steel rails to South Africa, and, unfortunately, these deliveries are now approaching completion. Imports of iron and steel into the Tees during April are up slightly on those of the corresponding month last year. Last month 11,669 tons of iron and steel were imported, as against 11,961 in April last year, and 6434 tons in April, 1913–14. The imports for the last six months total 81,873 tons, comprising 12,901 tons of pig iron, 56,547 tons of crude sheet bars, billets, blooms and slabs, and 12,425 tons of plates, bars, angles, joists and sheets. For the corresponding period a year ago the imports amounted to 77,460 tons.

Cleveland Iron Trade.

Continued absence of buyers from the Cleveland pig iron market is causing considerable anxiety. Increased business, either with Scotland or in markets overseas, is impossible at present prices, as alternative supplies are offered at much lower figures. Moreover, local and inland consumers are displaying strong reluctance to pay the prices which have ruled unchanged since the beginning of the year. Their needs are limited, and they are adhering strictly to a policy of hand-to-mouth purchases. In spite of all these depressing influences, however, the ironmasters refuse to reduce their quotations. Stocks of Cleveland iron are not increasing, but quantities of hematite stored are still heavy. No. 1 Cleveland foundry iron is 61s., No. 3 G.M.B. 58s. 6d., No. 4 foundry 57s. 6d., and No. 4 forge 57s.

Hematite Pig Iron.

There have been rather better export sales of East Coast hematite pig iron of late, and it would appear that price cutting has tempted buyers. The general market price of mixed numbers is 65s. 6d., with No. 1 quality at a premium of 6d. per ton. There are customers who claim they can buy at less, and there are makers who refuse to sell except on considerably higher terms.

Ironmaking Materials.

The foreign ore trade is idle, and it is difficult to ascertain the lowest terms on which contracts might be arranged. Nominally best Rubio is 15s. 9d. c.i.f. Tees. Blast-furnace coke is plentiful. Good average qualities are offered at 16s. for early delivery to works in this district. but consumers are not disposed to pay that price.

Manufactured Iron and Steel.

Business in the manufactured iron and steel trade matures very slowly, and producers of all commodities are urgently in need of orders. Some firms have increasing difficulty in keeping their plant in operation. There is a little more export inquiry, but actual business matures slowly. Nevertheless, prices are maintained.

The Coal Trade.

The Northern coal trade has assumed a much quieter appearance. As is usual at this season, the demand has fallen away, and industries generally are not taking any more fuel than they have done for a long time past. Large numbers of miners are under notice in Durham County, not on account of the quota system under the Coal Mines Act, but because, primarily, there are fewer orders, and, secondly, because minimum prices cannot be obtained for some classes of coal. Similar grades of fuel are grouped for limitation price purposes, but they are not of equal quality, and buyers naturally seek the best they can get at the minimum. Thus, some collieries are able to work very well, while others are idle. A dull summer is predicted for every kind of coal, as supplies abroad are plentiful, and industrial needs at home are so much under the average quantities, on account of the prevailing depression. Supplies of Northumberland steam coals are readily obtainable, with all descriptions quoted at the minimum. Best steams are at 13s. 6d., seconds 12s., and smalls 10s. There is a pronounced scarcity of inquiry in the Durham section, and every description is difficult to sell. Best gas qualities move slowly at 14s. 6d., with seconds at 13s. 6d. Coking unscreened is a nominal market at 13s. 3d., first quality bunkers are pressed on the market at 14s., and second kinds are 13s. 6d. Stocks of most classes of coke are increasing, and prices remain easy in consequence. Production has been curtailed, and there are still accumulations above market requirements. Gas makes are showing a seasonal quietness and export business in patent foundry makes is dull. Patent foundry coke is 15s. 6d. to 16s., beehive foundry coke 20s. to 24s., and special foundry coke 20s. to 22s.

SCOTLAND.

(From our own Correspondent.)

Shipbuilding.

THE output of new tonnage still reflects the depressed state of the industry, the returns for April only amounting to five vessels of 8511 tons aggregate. One vessel, a new oil tanker, of 7200 tons, practically accounted for the month's output. Since the beginning of this year

only twenty-eight vessels of 61,771 tons aggregate have been launched from Clyde yards, compared with sixty-two vessels of 147,199 tons aggregate in the same period last year. With regard to new business, April was slightly more productive than March, although the total amount is far below the standard necessary to maintain an average output.

Steel.

During the past week the scarcity of orders for steel has again been pronounced. There is a lack of activity at the works generally, and the production of all classes of material is far below capacity. Steel tubes are in a more depressed condition than for a long time back, and latest advices are not hopeful. Sheets have been just a shade better, though still very disappointing in respect to galvanised descriptions. Inquiries from the East are, however, said to be improving.

Iron.

Bar iron makers have not yet experienced the usual seasonal expansion in business, and conditions remain very dull. Steel re-rollers continue to suffer from English and continental competition, and in spite of reduced prices make little headway. Re-rolled steel bars are quoted £6 10s. home and £6 7s. 6d. per ton export.

Pig Iron.

The output from the seven furnaces operating in Scotland is easily sufficient to meet all demands. Prices are unchanged, but weakness is apparent. Shipments from Glasgow last week only amounted to 29 tons for overseas, compared with 368 tons foreign and 46 tons coastwise in the same week last year.

Scrap.

There has not been much demand for scrap for some time, and prices are inclined to ease still further from the present levels of 53s. 6d. for cast iron machinery and 45s. per ton for heavy steel.

Coal.

Apart from inquiries for home fuel for the next twelve months and some for washed nuts for the South of England, the Scottish coal market is devoid of interest. Home demands are rapidly decreasing as the season advances and exports are restricted to small lots for immediate or early shipment. Colliery sidings are becoming more and more congested with unsold fuel, and idle time is increasing in all districts. Prices as a rule show little change from last week, but the tendency is easier. Aggregate shipments amounted to 205,539 tons, against 208,831 tons in the preceding week and 258,460 tons in the same week last year.

WALES AND ADJOINING COUNTIES.

(From our own Correspondent.)

The Coal Trade.

STEAM coal market conditions have been devoid of any feature during the past week, except that the collieries have not been quite so well supplied with tonnage. Shipments last week, according to the Great Western Railway Company's figures, amounted to 465,300 tons, which include shipments of anthracite, and this total compares with 491,700 tons for the preceding week. It is not surprising that there was a slight reduction in the quantity, as the week finished up with 35 idle tipping appliances at the various docks and only one steamer waiting to berth. As the result of further arrivals of tonnage over the week-end, there were 23 idle tips on Monday, with 10 steamers waiting, seven of the latter being at Swansea, which indicates that operations in anthracite coals are fairly active. On Tuesday, the number of idle appliances was 26, and as this figure is higher than the normal, the probability is that shipments this week will not turn out very satisfactory. The fact that there was no work in the coalfield on Monday on account of May-day demonstrations kept down the supplies of coal available, but it is feared that stocks of quite a number of qualities are abnormally heavy, especially smalls, while even some of the large coals are not too well placed for a ready outlet. In a number of instances this is not because there are no orders to execute, but for the reason that prompt tonnage is so scarce. The tone of the outward freight market, particularly for the Mediterranean upper ports, is very steady, and is well maintaining the recent improvement, but it would be idle to pretend that there is anything in the nature of a boom in shipping. The unusually heavy quantity of tonnage which is still on the laid-up list will, for a very long time, exercise a restraining influence upon the upward tendency of freight rates, because, as soon as rates touch anything like a remunerative level, shipowners will only be too ready again to place their tonnage in commission. It is, however, encouraging to note that there is a better outlook for shipping, and the more tonnage that is operating the better it will be for the coal trade, inasmuch as it means the consumption of coals as bunkers. From the point of view of new business in steam coals, it cannot be said that the current demand has expanded to an appreciable extent, though a few orders for single cargoes have been placed, and there is an inquiry from Portugal for about 30,000 to 40,000 tons for loading from now to the end of the year.

Losses in Coal Industry.

According to the secretary of the South Wales Coalowners' Association, the report of the joint accountants of the Coal Trade Conciliation Board for the three months ended last January, was the most unsatisfactory issued since that covering the period of three months ended January, 1929. Apart from the depression in trade, there was the general stoppage of work in the coalfield from January 1st to 18th, and compared with the three months ended October, 1930, production showed a decrease of nearly 2,000,000 tons, or between 18 and 19 per cent., while the loss recorded by the auditors amounted to £185,542, or 5·4d. per ton. This loss, compared with a profit in the previous three months of 3·57d. per ton, and with a profit of 9·94d. per ton in the corresponding period of last year. There was no material difference in the realised average pithead price per ton calculated on the coal produced. It was less than one penny per ton below that of the previous three months, but the interruption of work during the first fortnight in January burdened the industry with a heavy expenditure on maintenance, and costs, other than wages, increased during the quarter by 7¼d. per ton. As a direct consequence of the strike in January, the workmen unnecessarily forfeited about £866,000 in wages, as the total amount of wages distributed over the period of three months ended January 31st was only £3,902,000, compared with £4,768,000 in the previous three months. The economic wage certified by the accountants was 2·61 per cent. on the 1915 basis rates, and if there had been no minimum this is the percentage that would have operated from March 1st. Under the terms of the agreement, however, the owners will have to pay a minimum wage percentage of 20 per cent. for the three months ending May 31st next. The audit now issued completes a record of three years' operation, and during that period the loss suffered by the industry in South Wales amounted to £4,157,267, or 5·88d. per ton on an aggregate output of 169,514,348 tons.

LATER.

At a meeting of the employees at the Mannesmann Tube Works, Landore, on Tuesday, the statement was made by Mr. Dennison, the assistant secretary of the Iron and Steel Trades Confederation, that the management of the company's works at Newport had been warned that any further attempt to secure blackleg labour at Landore would result in the withdrawal of the labour at the Newport works.

Iron and Steel Works.

It is reported that the Briton Ferry Steel Company, Ltd., has decided upon a large programme of reconstruction and modernising work, including the installation of new electrically driven rolling plant. While some of the developments contemplated will take some time to materialise, it is anticipated that they will possibly include the erection of blast-furnaces. The £76,500 order for steel rails and sleepers placed by the Nigerian Railways with Guest, Keen and Nettlefolds, Ltd., has now been in hand about a fortnight, the larger portion of the work being executed at the two Port Talbot works, and as a result the rail bank department of the steel works has sufficient work to maintain its employees for a period of about twelve months. Work was not resumed at the British Mannesmann Tube Company at Landore Works last week, and it was stated that not enough men had accepted the company's terms to enable work to be begun. Since then, however, the general manager of the undertaking has stated that, in accordance with the company's programme, arrangements are progressing satisfactorily. He further states that they have got all the men they want, but that no definite indication can be given as to when the works will re-start as the company is in the throes of reorganisation.

Coalfield Items.

A resumption of work has taken place at the Blaenserchan Colliery, which was rendered idle by the big power-house fire on April 12th. This was welcome news for the colliery workers in the Pontypool, Abersychan and Talywain area. As regards the Bedwas Colliery, no agreement has yet been come to regarding a new price list. This colliery has been idle about six months. Ministry of Mines officials are keeping in touch with the position, but last week-end over 100 officials who were working on day-to-day contracts received 24 hours' notice and only a skeleton staff now remains to keep the pits open.

A Ship-repairing Contract.

Keen competition for the repair of the steamer "Ruckinge," which recently went ashore off Oporto, has resulted in the order being secured by Charles Hill and Sons, Ltd., of Bristol. It is stated that the price was round about £4000, and there is about a month's work on the steamer. The repairs involve the renewal of a large number of bottom plates, besides lifting the engines and effecting repairs to the tank tops and floors and frames.

Current Business.

New business continues to be rather quiet, and the position of individual collieries varies considerably. Tonnage is not being put at their disposal as readily as many of them desire. Prices show no change and are almost invariably on the minima. Small coals are especially plentiful. The pithead price of best large Welsh house coal has been reduced by 1s. 6d. per ton as from Friday in last week. The current quotation is, therefore, 25s. per ton. The last alteration in prices was on October 1st last, when there was an increase of 1s. 6d. per ton. It is expected that the new price will operate until the end of September next. Patent fuel and coke display no alteration, and pitwood remains steady.

THE INSTITUTE OF BRITISH FOUNDRYMEN.

THE programme of arrangements in connection with the twenty-eighth Annual Conference of the Institute of British Foundrymen, which is to be held in Birmingham from June 9th to 12th, 1931, has now been issued.

The meeting opens with a reception by the Lord Mayor and the Lady Mayoress of Birmingham at the Council House on Tuesday evening, June 9th.

On Wednesday morning, Mr. A. Harley will deliver his Presidential address, and a number of papers will be presented and discussed. In the afternoon visits will be paid to works and in the evening the annual banquet, followed by a dance, will be given at the Grand Hotel.

Thursday will be spent in Coventry, where more papers will be read and works visited.

On Friday a motor coach excursion to the Cotswold Country has been arranged.

The papers which will be presented at the Conference are as follows:—

American Exchange paper, "The Effect of Elevated Temperatures on Grey Iron Castings," by G. W. Spring, Chicago, U.S.A.

Belgian Exchange paper, "Factors in the Conductivity of Irons," by Professor H. Thyssen, University of Liége.

French Exchange paper, "The Laboratory and the Foundry," by M. Arzens.

"The Merchandising of Castings," by Eric N. Simons (Edgar Allen and Co., Ltd.).

"Sands and Sand Testing," by J. G. A. Skerl, D.Sc. (Associate Member), British Cast Iron Research Association.

"Silicon as an Alloying Element," by John Arnott, A.I.C. (Member), G. and J. Weir, Ltd., Glasgow.

"High Duty Light Alloys," by W. C. Devereux (High Duty Alloys, Ltd.).

"The Relationship Between the Engineering and the Foundry Trades," by L. H. Pomeroy, M.I. Mech. E., M.I.A.E. (managing director, Daimler Company, Ltd.). This paper will be read *in extenso*.

"Recent Developments in Cast Iron in Great Britain," by J. G. Pearce, M.Sc., M.I.E.E. (Member), director, British Cast Iron Research Association.

CONTRACTS.

SOCIETE D'EXPLOITATION DES PROCEDES DABEG, of Paris, has received an order for economiser equipments of the Dabeg system for 130 locomotives from the Paris-Lyons-Mediterranean Railway.

THE WESTINGHOUSE BRAKE AND SAXBY SIGNAL COMPANY, Ltd., have secured a contract for the supply of metal rectifiers to the borough of Bromley Electricity Department, in connection with the change over from D.C. to A.C. mains.

THE GENERAL ELECTRIC COMPANY, Ltd., of Magnet House, Kingsway, W.C. 2, have received an order from the London Electric Railway Company for 372 heavy railway motors, which are rated at 240 B.H.P., 575 volts, are self-ventilated, and fitted with roller armature bearings.

THE NETHERLAND SHIPBUILDING COMPANY, of Amsterdam, has received an order from Scandinavian owners for three cargo ships, each 456ft. by 61ft. by 39ft. 6in. The main propelling engine in each ship will be an A.E.G. Diesel motor built by Messrs. Stork Brothers, Hengelo.

THE PULSOMETER ENGINEERING COMPANY, Ltd., of Reading, have received an order from the Great Western Railway Company for the supply and erection of electrically driven centrifugal pumping plant at Barry Docks. The eight pumps are to deliver water at a pressure of 800 lb. per square inch. The Pulsometer Company has also in hand a plant for similar purposes for Leith Docks.

BRITISH INSULATED CABLES, Ltd., of Prescot, Lancs., have received an order from the Central Electricity Board for linking the North-Western England and North Wales section of the grid scheme with the Liverpool area. The new line will connect up with the standard tower lines coming in from Preston and Warrington at Litherland. From this point it is to be brought to Liverpool along the Leeds and Liverpool Canal, the conductors being supported over the canal by means of lattice steel gantries spanning the canal. These structures will be 70ft. high and will carry six steel cored aluminium conductors and one earth wire.

PERSONAL AND BUSINESS ANNOUNCEMENTS.

MR. A. HOWARD ROMANS has been appointed by Edgar Allen and Co., Ltd., Sheffield, technical and sales representative in the Birmingham and Midlands district. The address will be Midland Bank Chambers, Stephenson-street, Birmingham.

FRANCIS THEAKSTON, Ltd., ask us to state that Mr. Francis Theakston has only resigned his position as managing director and has not, as stated in our issue of the 1st inst., severed his connection with the firm. He remains the chairman of the company, a permanent director and a shareholder.

CATALOGUES.

MIDLAND IRON COMPANY, Ltd., Rotherham.—A booklet giving a list of the firm's products.

EDGAR ALLEN AND CO., Ltd., Sheffield.—Particulars of Stag single-roll crushers and crushing rolls.

JOHN CASHMORE, Eagle Works, Great Bridge, Staffs.—Latest list of second-hand machinery for sale.

BRUSH ELECTRICAL ENGINEERING COMPANY, Ltd., Loughborough.—Publication No. 5001 on "N" type motors.

A. REYROLLE AND CO., Ltd., Hebburn-on-Tyne.—Pamphlet No. 742, describing the Split-Pilot feeder protective system.

JOHN DAVIS AND SON (DERBY), Ltd., All Saints Works, Derby.—Leaflet 617 on the "M-L" pneumatic electric lamp.

THE INSTITUTION OF ELECTRICAL ENGINEERS: SCOTTISH CENTRE.—The fourth annual golf competition in aid of the Institution Benevolent Fund, for the trophy presented by Messrs. W. L. Winning and Andrew Hutcheson, will be held at Gleneagles on Thursday, June 11th, 1931.

SOCIETY OF FRIENDS AND PATRONS OF THE HAMBURG EXPERIMENTAL TANK.—The Gesellschaft der Freunde und Förderer der Hamburgischen Schiffbau-Versuchsanstalt, will hold its tenth general meeting from May 27th to 29th in Lindau, Konstanz, Zürich, and Winterthur. On Wednesday, May 27th, Dr.-Ing. H. Kreitner, of St. Pölten, will read a paper on "The Hydraulic Principles of the Voith-Schneider Propeller," while Oberingenieur R. Temple, of Deggendorf, will speak on "Shipbuilding Construction Problems as Influenced by the Voith-Schneider Method of Propulsion," and Dr.-Ing. G. Kempf will read a paper on "The Steering of Ships as Influenced by the Different Ship Forms in Open and in Limited Waterways." After the papers the party will inspect on the stocks at Lindau a typical motor ship fitted with the Voith-Schneider propeller and make demonstrative trips with sister ships running on Lake Constance. On Thursday, May 28th, the papers to be read will include one by Oberregierungsrat J. Altmayer, of Karlsruhe, on "The Navigation Facilities Between the Rhine and Lake Constance," while Oberingenieur K. Beschworon, of Regensburg, will speak on "Pull or Push Propulsion for Tug Service." Subsequently the new Diesel ferry boat "Konstanz" will be inspected, also the new paddle steamer "Stadt Ueberlingen." The party will divide into two groups on Friday, May 29th, and one group will visit the works of the Zeppelin Airship Company, the Maybach Motor Works, and the Dornier Metal Aircraft Works at Friedrichshafen, making air trips over Lake Constance; while others will travel to Zürich and Winterthur and inspect the works of Escher, Wyss and Cie. and Sulzer Bros.

Current Prices for Metals and Fuels.

IRON ORE.

N.W. Coast—	
(1) Native	16/- to 20/6
(1) Spanish	16/-
N.E. Coast—	
Native	18/- to 21/-
Foreign (c.i.f.)	15/9

PIG IRON.

	Home. £ s. d.	Export. £ s. d.
(2) Scotland—		
Hematite	3 12 0	—
No. 1 Foundry	3 16 0	—
No. 3 Foundry	3 13 6	—
N.E. Coast—		
Hematite Mixed Nos.	3 5 6	3 5 6
No. 1	3 6 0	3 6 0
Cleveland—		
No. 1	3 1 0	3 1 0
Siliceous Iron	3 1 0	3 1 0
No. 3 G.M.B.	2 18 6	2 18 6
No. 4 Foundry	2 17 6	2 17 6
No. 4 Forge	2 17 0	2 17 0
Mottled	2 16 6	2 16 6
White	2 16 6	2 16 6
Midlands—		
(c) Staffs.—	(*Delivered to Station.*)	
All-mine (Cold Blast)	—	—
North Staffs. Forge	3 6 0	—
„ „ Foundry	3 11 0	—
(c) Northampton—		
Foundry No. 3	3 7 6	—
Forge	3 2 6	—
(c) Derbyshire—		
No. 3 Foundry	3 11 0	—
Forge	3 6 0	—
(3) Lincolnshire—		
No. 3 Foundry	—	—
No. 4 Forge	—	—
Basic	—	—
(4) N.W. Coast—		
N. Lancs. and Cum.—		
Hematite Mixed Nos.	4 1 6 (a) / 4 3 6 (b) / 4 8 6 (c)	— / — / —

MANUFACTURED IRON.

	Home. £ s. d.	Export. £ s. d.
Scotland—		
Crown Bars	10 5 0	9 15 0
Best	—	—
N.E. Coast—		
Iron Rivets	11 10 0	—
Common Bars	10 10 0	—
Best Bars	11 0 0	—
Double Best Bars	11 10 0	—
Treble Best Bars	12 0 0	—
Lancs.—		
Crown Bars	10 5 0	—
Second Quality Bars	8 15 0	—
Hoops	13 0 0	—
S. Yorks.—		
Crown Bars	10 5 0	—
Best Bars	11 0 0	—
Hoops	12 0 0	—
Midlands—		
Crown Bars	9 10 0 to 10 7 6	—
Marked Bars (Staffs.)	12 0 0	—
Nut and Bolt Bars	8 12 6 to 9 0 0	—
Gas Tube Strip	10 17 6 to 11 0 0	—

STEEL. (*d*)

	(6) Home. £ s. d.	(7) Export. £ s. d.
(5) Scotland—		
Boiler Plates (Marine)	10 10 0	10 10 0
„ „ (Land)	10 10 0	10 0 0
Ship Plates, ½in. and up	8 15 0	7 15 0
Sections	8 7 6	7 7 6
Steel Sheets, ¼in.	8 5 0	8 0 0
Sheets (Gal. Cor. 24 B.G.)	11 7 6	11 0 0

STEEL (*continued*).

	Home. £ s. d.	Export. £ s. d.
N.E. Coast—		
Ship Plates	8 15 0	7 15 0
Angles	8 7 6	7 7 6
Boiler Plates (Marine)	10 10 0	—
„ „ (Land)	10 0 0	—
Joists	8 15 0	7 7 6
Heavy Rails	8 10 0	—
Fish-plates	12 0 0	—
Channels	10 5 0	£9 to £9 5s.
Hard Billets	8 2 6	—
Soft Billets	6 17 6	—
N.W. Coast—		
Barrow—		
Heavy Rails	8 5 0	—
Light Rails	8 10 0 to 8 15 0	—
Billets	6 10 0 to 9 0 0	—
Manchester—		
Bars (Round)	9 7 6	—
„ (Small Round)	6 15 0	—
Hoops (Baling)	10 0 0	9 15 0
„ (Soft Steel)	9 0 0	8 15 0
Plates	8 17 6 to 9 2 6	—
„ (Lancs. Boiler)	9 2 6	—
Sheffield—		
Siemens Acid Billets	9 10 0 (basis)	—
Hard Basic	8 12 6 and 9 2 6	—
Intermediate Basic	7 2 6 and 7 12 6	—
Soft Basic	6 5 0	—
Hoops	9 10 0 to 9 15 0	—
Soft Wire Rods	7 15 0	—
Midlands—		
Small Rolled Bars	7 0 0 to 8 0 0	—
Billets and Sheet Bars	5 5 0 to 5 15 0	—
Galv. Sheets, f.o.b. L'pool	11 0 0	—
(2) Staffordshire Hoops	9 10 0	—
(d) Angles	8 7 6	—
(d) Joists	8 15 0	—
(d) Tees	9 7 6	—
(d) Bridge and Tank Plates	8 17 6	—
Boiler Plates	9 0 0 to 9 2 6	—

NON-FERROUS METALS.

Swansea—	
Tin-plates, I.C., 20 by 14 f.o.b.	14/9 to 15/-
Block Tin (cash)	103 15 0
„ (three months)	105 2 6
Copper (cash)	40 0 0
„ (three months)	40 13 9
Spanish Lead (cash)	11 13 9
„ „ (three months)	11 18 9
Spelter (cash)	10 10 0
„ (three months)	11 0 0
Manchester—	
Copper, Best Selected Ingots	44 0 0
„ Electrolytic	44 10 0
„ Strong Sheets	75 0 0
„ Tubes (Basis Price), lb.	0 0 10½
Brass Tubes (Basis Price), lb.	0 0 9½
„ Condenser, lb.	0 0 11¾
Lead, English	13 7 6
„ Foreign	12 10 0
Spelter	11 5 0
Aluminium (per ton—raw ingot)	£95

FERRO ALLOYS.

	Per Ton.	Per Unit.
Tungsten Metal Powder	1/11½ per lb.	
Ferro Tungsten	1/8½ per lb.	
Ferro Chrome, 4 p.c. to 6 p.c. carbon	£20 10 0	7/-
„ „ 6 p.c. to 8 p.c.	£19 10 0	7/-
„ „ 8 p.c. to 10 p.c.	£19 0 0	7/-
„ „ Specially Refined		
„ „ Max. 2 p.c. carbon	£31 0 0	10/-
„ „ „ 1 p.c. carbon	£34 0 0	12/-
„ „ „ 0·70 p.c. carbon	£36 0 0	14/-
„ „ „ carbon free	10d. per lb.	
Metallic Chromium	2/7 per lb.	
Ferro Manganese (per ton)	£11 0 0 for home	
„ „ „	£11 10 0 for export	
„ Silicon, 45 p.c. to 50 p.c.	£11 0 0 scale 5/- per unit	
„ „ 75 p.c.	£18 0 0 scale 7/- per unit	
„ Vanadium	12/0 per lb.	
„ Molybdenum	4/2 per lb.	
„ Titanium (carbon free)	9d. per lb.	
Nickel (per ton)	£170	
Ferro Cobalt	9/- per lb.	

FUELS.

SCOTLAND.

	Export.
Lanarkshire—	
(f.o.b. Glasgow)—Steam	14/-
„ „ Ell	14/9
„ „ Splint	14/9 to 16/6
„ „ Trebles	12/-
„ „ Doubles	10/6
„ „ Singles	9/-
Ayrshire—	
(f.o.b. Ports)—Steam	13/-
„ „ Jewel	17/-
„ „ Trebles	12/-
Fifeshire—	
(f.o.b. Methil or Burntisland)—Steam	11/6 to 12/3
Screened Navigation	16/6 to 17/6
Trebles	11/6 to 12/6
Doubles	10/6 to 11/-
Singles	9/-
Lothians—	
(f.o.b. Leith)—Best Steam	12/-
Secondary Steam	11/6
Trebles	12/- to 12/6
Doubles	11/- to 11/3
Singles	9/-

ENGLAND.

(8) N.W. Coast—	
Steams	20/-
Household	30/- to 51/-
Coke	20/- to 20/6
Northumberland—	
Best Steams	13/6
Second Steams	12/-
Steam Smalls	10/-
Unscreened	12/6 to 13/-
Household	27/- to 39/-
Durham—	
Best Gas	14/6
Second	13/3 to 13/6
Household	25/- to 37/-
Foundry Coke	26/- to 28/

Sheffield—	Inland.	
Best Hand-picked Branch	25/6 to 27/-	—
Derbyshire Best Bright House	24/- to 26/-	—
Best House Coal	22/- to 23/-	—
Screened House Coal	19/6 to 20/6	—
„ „ Nuts	16/6 to 17/6	—
Yorkshire Hards	15/- to 16/6	—
Derbyshire Hards	15/- to 16/6	—
Rough Slacks	9/- to 10/-	—
Nutty Slacks	7/- to 8/-	—
Smalls	4/6 to 6/6	—
Blast-furnace Coke (Inland)	12/3 on rail at ovens	
Furnace and Foundry Coke (Export), f.o.b. 15/- to 16/-		

(9) SOUTH WALES.

Cardiff—	
Steam Coals :	
Best Smokeless Large	20/- to 20/3
Second Smokeless Large	18/9 to 19/9
Best Dry Large	18/6 to 19/6
Ordinary Dry Large	17/9 to 18/-
Best Black Vein Large	18/6 to 18/9
Western Valley Large	18/- to 18/6
Best Eastern Valley Large	18/- to 18/3
Ordinary Eastern Valley Large	17/6 to 17/9
Best Steam Smalls	13/6 to 14/-
Ordinary Smalls	12/- to 13/6
Washed Nuts	18/- to 22/-
No. 3 Rhondda Large	19/9 to 20/3
„ „ Smalls	15/6 to 16/-
No. 2 „ Large	17/- to 17/3
„ „ Through	15/6 to 16/-
„ „ Smalls	14/- to 14/3
Foundry Coke (Export)	22/- to 36/6
Furnace Coke (Export)	16/6 to 17/6
Patent Fuel	20/6 to 21/-
Pitwood (ex ship)	23/6 to 23/9
Swansea—	
Anthracite Coals :	
Best Big Vein Large	35/- to 37/6
Seconds	27/- to 31/6
Red Vein	22/6 to 27/6
Machine-made Cobbles	41/6 to 45/-
Nuts	43/- to 46/-
Beans	24/9 to 28/3
Peas	20/- to 21/6
Breaker Duff	8/6 to 9/-
Rubbly Culm	8/6 to 9/6
Steam Coals :	
Large	20/6 to 21/6
Seconds	18/- to 20/-
Smalls	11/6 to 13/-
Cargo Through	16/- to 17/6

(1) Delivered. (2) Net Makers' Works. (3) f.o.b. Makers' Works, approximate. (4) Delivered Sheffield. (5) Glasgow, Lanarkshire, and Ayrshire. (6) Home Prices—All delivered Glasgow Station. (7) Export Prices—f.o.b. Glasgow. (8) Except where otherwise indicated, coals are per ton at pit for inland and f.o.b. for export, and coke is per ton on rail at ovens and f.o.b. for export. (9) Per ton f.o.b. (*a*) Delivered Glasgow. (*b*) Delivered Sheffield. (*c*) Delivered Birmingham. (*d*) Rebate : Joists (minimum), 22/6 ; Ordinary Ship, Bridge, and Tank Plates and Sections, 15/- if home consumers confine purchases from associated British Steel Makers. (*e*) Delivered Black Country Stations.

French Engineering Notes.

(From our own Correspondent in Paris.)

French Tariffs.

WHATEVER may be the ultimate result of the preliminary negotiations between the Board of Trade and the French Ministry of Commerce for a readjustment of tariffs it would be unwise to anticipate an early improvement in trading facilities. French appreciations of the situation show that the fear of French products being excluded from Great Britain by a tariff barrier has been allayed by recent events, and they indicate more particularly that the British cannot hope to benefit from the economic reconstruction of Europe unless they help to carry it through. This implies, of course, that the British are expected to support the French plan, about which little is known at present, except, that, owing to the peculiar situation of France it will be largely of a financial character. The Germans are reported to be waiting for the French plan and are prepared to work in their scheme with it, if possible.

International Colonial Exhibition.

The objects of the International Colonial Exhibition in the Bois de Vincennes, Paris, which is being officially opened this week, are to create a national interest in the Colonies, to facilitate the provision of money for colonial development, such as the construction of roads railways, ports and the like, and to show the world the importance of the newly created French Empire, which, in area and population, is second only to that of the British. It is also hoped that the Exhibition will stimulate business during the present period of trade depression. It will almost certainly prepare the way for a colonial activity which will help in the recovery of French economic prosperity. As is usually the case, the opening day will see the Exhibition in a backward state, but it is already evident that, from a spectacular point of view, it will be one of the most brilliant of its kind yet organised. The keynote of the architectural features is originality. There are striking reproductions of temples, such as the famous Angkor in Indo-China, and a Buddhist temple in the Dutch East Indies. The pavilions and palaces of engineering and others have been designed in harmony with the colonial scheme and may offer new ideas in utilitarian architecture. The only new thing in construction is the replacing of plaster, in many cases, with wood sawn in sheets and nailed on timber frames. An attractive finish with valuable woods is given to structures in this way, some of them having the appearance of being built solidly from colonial timber. There will be seen the latest advance in the science of illumination, which is being developed by the collaboration of the artist with the lighting engineer. The light will be diffused or reflected, without any light being directly visible anywhere. All the principal avenues are lined with standards from which are suspended chaplets of half a dozen inverted cones with lamps inside. In another case the light is reflected from lamps in green shades on to white discs. Around the Lake Daumesnil the illumination effects promise to be particularly novel and artistic. There will be much to be learned in the way of illumination. So far as regards the exhibits, there is at present very little to be seen. It was interesting to note that the only mechanical devices employed in the Exhibition grounds for unloading goods were the motor mobile cranes of Ransomes and Rapier, Ltd., of Ipswich.

Engine Knocking.

For a considerable time past Monsieur Dumanois has been carrying out experiments in association with the Office National des Recherches et Inventions with a view to ascertaining the cause of knocking in petrol engines when running at above a certain temperature. By a process of deduction it seemed fairly certain that the phenomenon was due to the action of peroxides, but there was nothing to prove the truth of those deductions. The matter has now been settled by experiments with a four-stroke motor cycle engine, 70 mm. by 70 mm., the results of which have been communicated to the Académie des Sciences. The engine was coupled up with a 2 horse-power electric motor by a shaft on which was fixed a brake drum. The engine cylinder was lagged with asbestos through which passed a thermometer to show the temperature of the cylinder. A thick glass port was let into the combustion chamber for observation. While the engine was developing its full brake power, and the temperature was rising, the ignition was switched off now and then and the electric motor was run to keep the petrol engine at the same speed. Analyses of the exhaust showed a complete absence of aldehydes and peroxides so long as the cylinder temperature was below 270 deg. Cent. At that temperature knocking began. The brake was released and the ignition switched off simultaneously, when the engine continued to run for more than a minute. Observation through the port revealed that there was no flame and, consequently, no self-ignition. The engine was stopped and then turned by the electric motor, when the exhaust was found to contain notable quantities of aldehydes and peroxides.

Fast Transports.

In the national programme of public works, which is still being held up because the funds have not been voted, there is included the construction of three special ships which are to be fast enough to carry troops across the Mediterranean between Algiers and Marseilles during the night. Monsieur Rougeron, a well-known naval engineer, proposes that the ships should be built something on the lines of the latest Italian or German small cruisers, with a tonnage of between 4000 and 7000 and capable of steaming at from 25 to 27 knots. Evidently, for passenger service, convenience would have to be sacrificed, but as the crossing will be made during the night the accommodation would be the same as in railway trains, the sleeping berths being arranged in a similar manner. The extra cost of running the new ships would, says Monsieur Rougeron, be made up for by the shorter time in crossing and a reduction in the number of attendants and stores carried.

British Patent Specifications.

When an invention is communicated from abroad the name and address of the communicator are printed in italics.

When an abridgment is not illustrated the Specification is without drawings.

Copies of Specifications may be obtained at the Patent Office, Sale Branch, 25, Southampton-buildings, Chancery-lane, W.C., at 1s. each.

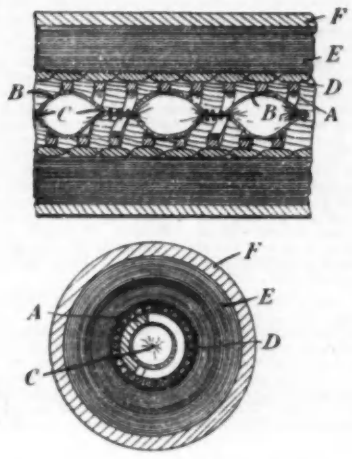
The date first given is the date of application; the second date, at the end of the abridgment, is the date of the acceptance of the complete Specification.

TRANSMISSION OF POWER.

345,495. March 24th, 1930.—ELECTRIC CABLES, *International General Electric Company, Inc., of 120, Broadway, New York, United States of America.*

In the production of modern high-pressure electric cables, the insulating layers are impregnated with substances comprising for the most part oils having a high thermal coefficient of expansion. On an increase of temperature of the cable, the outer sheath, which is generally made of a lead covering, expands, and, if the very low elastic limit is exceeded, does not again contract to its original form. Hence the volume of the cable

N°345,495



becomes greater, and is thus no longer completely filled out in the cooled state by the impregnating medium. Hollow spaces are produced which are either empty or filled with the gasified constituent parts of the insulating medium and give rise to breakdown in the cable. According to the invention, within the protecting spiral A of an electric conductor there is an elastic tubing B filled with inactive gas, such as nitrogen or carbon dioxide, and subdivided into single separate gas-tight chambers by the tied joints C. The electric conductor D is enclosed by paper insulation E and a lead covering F.—*March 26th*, 1931.

PUMPING AND BLOWING MACHINERY.

345,574. May 31st, 1930.—PUMPS FOR CIRCULATING MERCURY, *The British Thomson-Houston Company, Ltd., Crown House, Aldwych, London, W.C. 2.*

This pump is put forward for the circulation of mercury, but for what purpose is not disclosed. It comprises a rotor A, in the periphery of which there are arranged helical channels B. (It will be noted that the drawing does not indicate the helical

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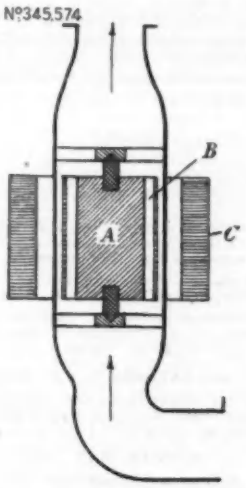

formation of the grooves, but they are so described in the specification.) Outside the casing of the rotor there is the stator C of an A.C. motor. The result is that the mercury in the channels B acts as the winding of a squirrel cage motor, for the driving of the rotor, and, incidentally, is propelled forward by the helical form of the grooves.—*March 26th*, 1931.

TRAMWAYS AND RAILWAYS.

345,233. December 7th, 1929.—RAILWAY ELECTRIFICATION, James Matthew Fay, of 88, Merrion-square, Dublin; James Joseph Drumm, M.Sc., of University College, Dublin; and Celia, Ltd., of 42 and 43, St. Stephen's-green, Dublin.

In accordance with this invention, locomotives or motor coaches carry storage batteries of very low internal resistance, and capable of being charged at very high rates. The energy for charging the battery is supplied over short sections of the line by means of a third rail A or overhead conductor connected to the source of supply, the conductor being normally situated at a station and extending, say, for anything from half a mile to three miles at each side of the station, whilst the sections of rail or conductor are spaced apart from one another at intervals of, say, 10 to 30 miles. In some cases charging might be effected while the train is standing in a terminal station from a transmission line B, connected to a rectifier C, which would also serve for supplying D.C. under running conditions. The third rail or other conductor would normally be dead, and would be switched in when required, either manually or automatically. In the drawing, D indicates the train-charging switch operated

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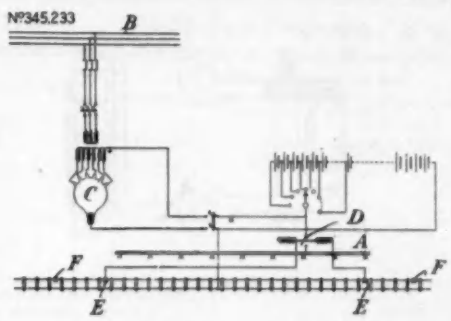

by a relay energised with current from the traction rail on the operation of triggers E. In order to improve the load factor, a battery might be arranged to work in parallel with the rectifier, this battery being charged during the periods when the train batteries are not drawing current. For accelerating trains leaving stations, a direct supply might be drawn from the supply instead of from the batteries. The triggers F serve for giving a signal to the driver when approaching a charging section, so that he may move the collecting shoes into position for picking up current.—*March 26th*, 1931.

SHIPS AND BOATS.

345,470. March 6th, 1930.—POWER PLANT FOR SHIP PROPULSION, The General Electric Company, Ltd., of Magnet House, Kingsway, London, W.C. 2, and Dr. Robert Gordon Jakeman, of the General Electric Company, Ltd., Engineering Works, Witton, Birmingham.

According to this invention, a multiple expansion reciprocating engine A is adapted to exhaust into a steam turbine B, provided with condensing plant. The engine and a D.C. motor C are both mechanically coupled to a propeller F, whilst a D.C generator D and a D.C. electric exciter E are both mechanically coupled to the turbine B. The generator D and the motor C are coupled by conductors G and H, whereby the generator D may drive the motor C. The motor C has a field winding J provided with a reversing switch K for reversing the motor. The generator D has a field winding L and a commutating pole winding M, the latter being connected in series with the conductor H. The exciter E has a field winding N connected in shunt through a regulating rheostat O and a series field winding P, connected in shunt across the commutating pole winding M of the generator D. Normally, when power is flowing from the generator D to the motor C, the winding P is adapted to exert a decompounding effect on the exciter E. The winding J of the motor C and the winding L of the generator D are connected in parallel across the armature of the exciter E. A control valve is provided for controlling the admission of steam to the engine A and for limiting the speed thereof, but no valve is provided for controlling the admission of steam to the turbine B from the engine, the plant as a whole being controlled by means of the steam valve of the engine A. The speed of the turbine B may therefore vary within wide limits. Under normal conditions,

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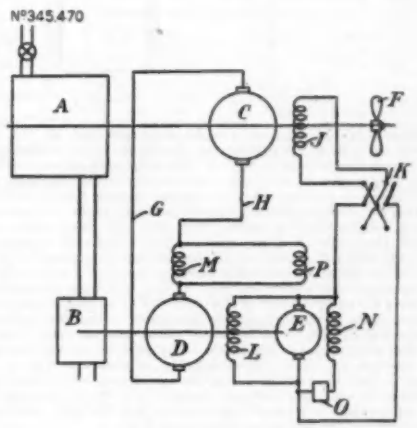
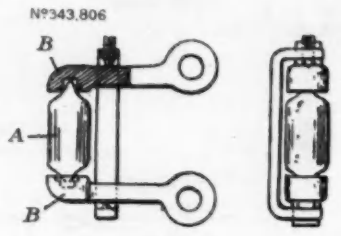


power is supplied to the propeller F directly from the engine A and from the turbine B by means of the generator D and motor C, whilst the current flowing at any time in the conductors G and H is proportional to the difference between the electromotive force of the generator D and the back electromotive force of the motor C. Further, since both the electromotive force of the generator and the back electromotive force of the motor depend on the voltage of the exciter E the difference between these two electromotive forces, and therefore the current flowing in the conductors G and H, also depends on the voltage of the exciter E. Provided the torque on the propeller F remains constant, there is no tendency for the current in the conductors G and H to vary. But if the torque on the propeller begins to fluctuate, as may happen when the ship runs into a heavy sea, the speed of the motor C will start fluctuating and will tend to cause undesirable fluctuations of the current in the conductors G and H. It will be seen, however, that if an increase in the speed of the motor C reduces the current flowing in the conductors G and H, the decompounding effect of the field winding P on the exciter E is reduced so that the voltage of the exciter is increased, thereby tending to maintain the current flow. On the other hand, if a decrease in the speed of the motor increases the current flowing, the voltage of the exciter E is reduced thereby tending to limit the current. There is therefore a strong tendency to stabilise the current flow. The effect of this is to increase the permissible difference between the speeds of the generator D and motor C for a given range of values of current flowing between generator and motor. Furthermore, at starting the engine A, the generator D may reach an appreciable speed, while the motor C is turning slowly, in which case the current in the conductors G and H is limited to a reasonable value.—*March 26th*, 1931.

MISCELLANEOUS.

343,806. April 9th, 1930.—FIRE-EXTINGUISHING SPRINKLERS, Mather and Platt, Ltd., and A. Roberts, Park Works, Manchester.

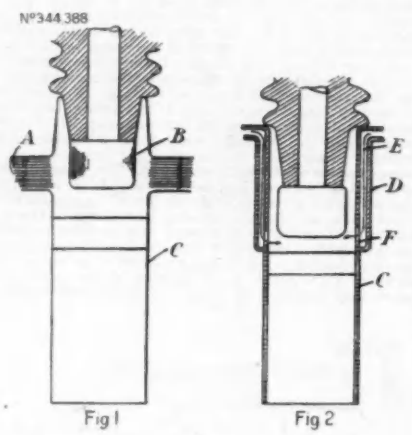
This device is evidently primarily intended for use in connection with fire-extinguishers, but might be applied to a variety of other uses where it is desired to release some member by increase of temperature. It comprises a sealed tube A of fused



quarts glass filled with a liquid having a high coefficient of thermal expansion. If it is heated sufficiently the tube explodes and permits the arms B B to collapse, under the influence of springs—not shown—to actuate any mechanism that may be desired. Several variations of the idea are illustrated, but there is no hint as to the liquid which should be used for filling the tube, neither as to the extent to which the tube should be filled.—*February 26th*, 1931.

344,388. November 29th, 1929.—ELECTRIC ARC RECTIFIERS, The British Thomson-Houston Company, Ltd., of Crown House, Aldwych, London, W.C. 2; and Frank Percy Whitaker, of 237, Clifton-road, Rugby.

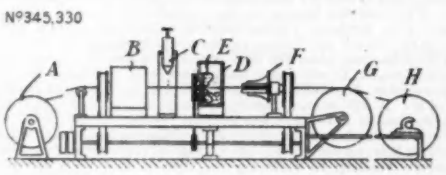
This invention relates to electric arc rectifiers of the mercury vapour type and more particularly to a novel arrangement of anode for this type of rectifier. It is general practice in such rectifiers to provide each anode with a shield, which may take the form of a cylinder which surrounds the anode at its upper end and which is open at its lower end so that the arc can reach the anode. It has been proposed to provide an aperture in the side of this shield which is connected to a part of the rectifier, which is efficiently cooled, so as to reduce the vapour pressure existing round the anode under certain conditions. It has also been proposed to provide an aperture in the side of the shield, but shielded by baffles from the anode, such baffles and aperture serving to carry away mercury which may condense inside the shield above the anode. According to the invention, in a shield for each anode of a mercury arc rectifier provided with one opening for the normal arc path between anode and cathode,



an additional opening or openings is provided at the top of or in the side of the shield, near the anode active surface and not shielded therefrom by baffles, the latter opening or openings being comparable in area with the first-mentioned opening, the object being to provide entry for vapour into the anode shield to increase the vapour pressure within the shield under certain conditions. Moreover, in order that the arc may follow its normal path, the inventors provide the additional opening or openings with a high ratio of surface to area of opening to facilitate deionisation of incoming mercury vapour. According to the arrangement shown in Fig. 1, the inventors provide an entrance to the upper end of the shield by arranging a number of annular discs A concentric with the anode B and secured close together with spaces in between them, the mercury vapour entering the interior of the shield C through the narrow passages left between the discs. Alternatively, as shown in Fig. 2, the shield C may be surrounded at its upper end by a concentric cylinder D, and the mercury vapour will enter through the annular passage E between the cylinders and through openings F near to the anode surface.—*March 2nd*, 1931.

345,330. December 17th, 1929.—ELECTRIC CABLES, Norah May Loudon and the London Electric Wire Company and Smiths, Ltd., of 7, Playhouse-yard, Golden-lane, London, E.C. 1.

This invention relates to improvements in the insulation of electric cables and has for one object to provide a fireproof insulation, particularly for electric cables covered with rubber or bitumen, &c. The cable to be treated is drawn from a drum A through a unit B, by means of which felted asbestos is applied and is thereafter passed under a device C by means of which an



inert liquid, for example, a silicate, is applied for binding purposes. The cable is then caused to travel through a unit D, by means of which an admixture of powdered selenium and zinc oxide is applied. The loose mixture of selenium and zinc oxide is agitated by means of a paddle E, so as to create a cloud of material which thereby settles uniformly upon the cable as it is traversed through the unit D. The cable, after leaving the unit D travels through a polishing device F, comprising pressure plates which are rotated around the cable to a take-off wheel G, and from thence to a receiving drum H.—*March 7th*, 1931.

345,594. July 2nd, 1930.—A PROCESS FOR REMOVING SULPHUR FROM INDUSTRIAL GASES BY MEANS OF A CYCLIC PROCESS WITH SIMULTANEOUS EXTRACTION OF PURE SULPHUR, S. Hunyady, 35, Bethlen-u., Rákospalota, Hungary, and K. Koller, 27, Podmaniczky-u., Budapest, VI, Hungary.

The object of the invention is to effect the removal of sulphur from industrial gases in a closed cyclic process in such a manner that with the rapid combining of the sulphur the regeneration of the active mass, together with direct extraction of pure sulphur, is carried out simply and cheaply without formation of acid. Finely divided manganic oxide is employed as the active mass and forms a very fine suspension with water. The gas to be purified is brought into intimate contact with an aqueous suspension of finely divided manganic oxide, the sulphuretted hydrogen in the gas being decomposed with formation of manganese sulphide and water. The reaction is represented by the following equation :—

$$Mn_2O_3 + 3\,H_2S = 2\,MnS + S + 3\,H_2O.$$

The aqueous mixture of manganese sulphide and sulphur is filtered and the residual moist mass is oxidised by means of air. This oxidation is effected more rapidly than in solution. By the action of atmospheric oxygen the manganese sulphide is converted with separation of sulphur into manganic hydroxide according to the equation

$$2\,MnS + 3\,O + 3\,H_2O = 2\,Mn(OH)_3 + 2\,S.$$

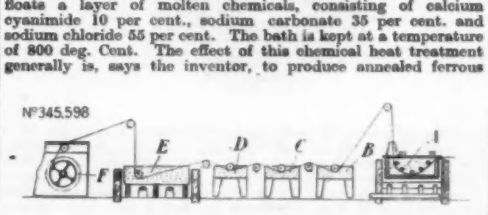
After oxidisation the precipitate is completely dried with warm dry air, the manganic hydroxide being decomposed into manganic oxide and water according to the equation

$$2\,Mn(OH)_3 = Mn_2O_3 + 3\,H_2O$$

The precipitate containing dry manganic oxide and sulphur is then treated with a solvent of sulphur, for example, trichloroethylene, at a temperature lower than the boiling point of the solvent, whereby the sulphur is obtained in solution. The solvent saturated with sulphur is now filtered, the trichloroethylene being vaporised so that pure sulphur is left as the residue. The manganic oxide, which possibly still contains adhering drops of solvent, is heated above the boiling point of the latter, whereby dried pure powdered manganic oxide is left which may be employed again directly for purifying the gases, so that the process may be carried out in an uninterrupted cycle. The solvent vapours are condensed and are again employed for dissolving the sulphur. The principal advantage of the process resides in the fact that the compounds of manganese are more readily converted than those of other metals suitable for gas purification, so that the closed cyclic process may be carried out without difficulty. A further advantage is that there is no acid formed in the cyclic process, so that it is unnecessary to provide the apparatus with an acid-resisting lining.—*March 26th*, 1931.

345,598. July 19th, 1930.—GALVANISED IRON WIRE, W. H. Potter, 121, Liverpool-road, Warrington.

In this process of galvanising the inventor first passes the wire through an annealing bath A of molten lead, on which there floats a layer of molten chemicals, consisting of calcium cyanimide 10 per cent., sodium carbonate 35 per cent. and sodium chloride 55 per cent. The bath is kept at a temperature of 800 deg. Cent. The effect of this chemical heat treatment generally is, says the inventor, to produce annealed ferrous



metal which is free from inclavated fusion products, such as iron scale or deposited carburised matter, whilst the adhering chemical residual substance which covers the ferrous metal acts as a protective coating against atmospheric oxidation while the metal is cooling off. The wire then passes through an acid bath B, a washing trough C, a bath of basic flux D, and the galvanising tank E, which is kept at a temperature of 450 deg. Cent. The wire is finally wound on the block F.—*March 26th*, 1931.

Forthcoming Engagements.

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of its insertion, the necessary information should reach this office on, or before, the morning of the Wednesday of the week preceding the meetings. In all cases the TIME *and* PLACE *at which the meeting is to be held should be clearly stated.*

TO-DAY.

INSTITUTION OF ELECTRICAL ENGINEERS: SCOTTISH CENTRE.—Foresters' Hall, Nicol-street, Dundee. Faraday Lecture, "The Birth of Electrical Engineering," by Professor W. Cramp. 7.30 p.m.

IRON AND STEEL INSTITUTE.—At the Institution of Civil Engineers, Great George-street, Westminster, S.W. 1. Annual meetings. 10 a.m. each day. For programme see page 440.

RAILWAY CLUB.—57, Fetter-lane, London, E.C. 4. "Great Southern Railway, Ireland," by Mr C. R. G. Stuart. 7.30 p.m.

ROYAL INSTITUTION OF GREAT BRITAIN.—21 Albemarle-street, Piccadilly, W. 1. Discourse, "The Measurement of Noise," by Dr. G. W. C. Kaye. 9 p.m.

FRIDAY AND SATURDAY, MAY 8TH AND 9TH.

INSTITUTION OF MUNICIPAL AND COUNTY ENGINEERS: NORTH-WESTERN DISTRICT.—Town Hall, Victoria-street, Morecambe and Heysham. 11 a.m.

MONDAY, MAY 11TH.

CHARTERED SURVEYORS' INSTITUTION.—12, Great George-street, Westminster, S.W. 1. "Valuations of the Assets of Public Companies," by Mr. Sydney A. Smith. 8 p.m.

IRON AND STEEL INSTITUTE.—At the Cleveland Technical Institute, Corporation-road, Middlesbrough. "Production Economy in Iron and Steel Works," by Mr. O. Cromberg; "The Melting Shop of the Appleby Iron Company, Ltd.," by Mr. A. Robinson. 7.30 p.m.

TUESDAY, MAY 12TH.

INSTITUTE OF FUEL: SOUTH WALES SECTION.—South Wales Institute of Engineers, Park-place, Cardiff. Joint meeting. Discussion, "Local Generation of Electrical Power Plus the Grid," by Major E. Ivor David. 6 p.m.

INSTITUTE OF MARINE ENGINEERS.—The Minories, London, E.C. 3. "Low Cost Motor Ships," by Mr. O. E. Jorgensen. 6 p.m.

INSTITUTION OF CIVIL ENGINEERS.—Great George-street, Westminster, S.W. 1. Annual General Meeting. 6 p.m.

TUESDAY TO FRIDAY, MAY 12TH TO 15TH.

NATIONAL SAFETY FIRST ASSOCIATION (INC.).—Leeds. Annual Congress.

WEDNESDAY, MAY 13TH.

INSTITUTE OF FUEL.—In the Rooms of the Chemical Society, Burlington House, Piccadilly, W. 1. "The Continuous Production of Water Gas from Powdered Fuel," by Dr.-Ing. Adolph Thau, of Berlin. 6 p.m.

ROYAL SOCIETY OF ARTS.—John-street, Adelphi, London, W.C. 2. "Architecture in Concrete on the Pacific Coast," by Major R. A. B. Smith. 8 p.m.

TELEVISION SOCIETY.—At University College, Gower-street London, W.C. 1. "The Development of Cuprous Oxide Photoelectric Cells," by Mr. H. Wolfson. 7 p.m.

THURSDAY, MAY 14TH.

INSTITUTION OF ELECTRICAL ENGINEERS.—Savoy-place, Victoria Embankment, London, W.C. 2. "Commemoration of Centenary of the Birth of David Edward Hughes (May 16th, 1831)," short discourse by Mr. S. Evershed. 6 p.m. Annual general meeting, 6.45 p.m. approximately.

IRON AND STEEL INSTITUTE.—At the Birmingham Chamber of Commerce, 95, New-street, Birmingham. "First Report on the Corrosion of Iron and Steel," being a report by a Joint Committee of the Iron and Steel Institute and the National Federation of Iron and Steel Manufacturers to the Iron and Steel Industrial Research Council; "Production Economy in Iron and Steel Works," by Mr. O. Cromberg; "On the Nature of Defective Laminations in Wrought Iron Bars and Chain Links," by Mr. H. J. Gough and Mr. A. J. Murphy; "The Melting Shop of the Appleby Iron Company, Ltd.," by Mr. A. Robinson. 7 p.m.

ROYAL AERONAUTICAL SOCIETY.—At the Royal Society of Arts, John-street, Adelphi, London, W.C. 2. "The Metal-clad Airship," by Mr. Carl B. Fritsche. 6.30 p.m.

THURSDAY AND FRIDAY, MAY 14TH AND 15TH.

UNIVERSITY OF LONDON.—At the Institution of Civil Engineers, Great George-street, Westminster, S.W. 1. "Steam Research in Europe and in America," by Professor Dr.-Ing. Max Jakob. *Thursday.*—"Optical Measurements." *Friday.*—"Special Thermal Properties and Processes of Water and Steam and a Note on International Steam Table Conferences and International Steam Table." 5.30 p.m. each day.

FRIDAY, MAY 15TH.

ROYAL INSTITUTION OF GREAT BRITAIN.—21, Albemarle-street, London, W. 1. Discourse, "Experimental Aspects of Hydrogen-Ion Concentration," by Dr. J. C. Philip, F.R.S. 9 p.m.

SATURDAY, MAY 16TH.

INSTITUTION OF MUNICIPAL AND COUNTY ENGINEERS.—Southern District Meeting at Cheltenham. Assemble Town Hall at 10.30 a.m.

WEDNESDAY, MAY 20TH.

MANCHESTER ASSOCIATION OF ENGINEERS.—Visit to the Broughton Copper Company, Ltd., Blackfriars-road, Salford. 2.30 p.m.

FRIDAY, MAY 22ND.

ROYAL INSTITUTION OF GREAT BRITAIN.—21, Albemarle-street, London, W. 1. Discourse, "X-ray Investigations of the Structure of Liquids," by Sir William Bragg, F.R.S. 9 p.m.

MONDAY, MAY 25TH.

ENGINEERING GOLFING SOCIETY.—Northern meeting at Gullane, No. 1 Course.

THURSDAY TO SATURDAY, MAY 28TH TO 30TH.

VEREIN DEUTSCHER CHEMIKER.—Vienna. Fifth general meeting for chemical apparatus. Symposium, "The Separation of Liquids and Solids."

SATURDAY TO SUNDAY, MAY 30TH TO JUNE 14TH.

INSTITUTE OF TRANSPORT.—Italian Tour and Congress. For provisional programme see page 359.

MONDAY TO FRIDAY, JUNE 1ST TO 5TH.

INTERNATIONAL FEDERATION FOR HOUSING AND TOWN PLANNING.—Berlin. Thirteenth International Housing and Town Planning Congress.

THURSDAY, JUNE 4TH.

ROYAL SOCIETY OF ARTS.—John-street, Adelphi, London, W.C. 2. "A New Form of Prime Mover and its Uses for Locomotives, Marine and other Engines," by Mr. J. F. J. Malone. 6 p.m.

WEDNESDAY TO SATURDAY, JUNE 17TH TO 20TH.

INSTITUTION OF MUNICIPAL AND COUNTY ENGINEERS.—Birmingham. Fifty-eighth annual general meeting and conference. For programme see page 524.

WEDNESDAY, JUNE 24TH.

STAFFORDSHIRE IRON AND STEEL INSTITUTE.—Annual excursion. Visit to the National Physical Laboratory, Teddington.

MONDAY TO SATURDAY, JUNE 29TH TO JULY 4TH.

INSTITUTION OF NAVAL ARCHITECTS.—Paris summer meeting. For programme see page 514.

MONDAY TO SATURDAY, JULY 13TH TO 18TH.

SOCIETY OF CHEMICAL INDUSTRY.—Jubilee Celebrations. For provisional programme see page 471.

THE PARSONS ASSOCIATION.—It is proposed to form a Parsons Association to commemorate the life and work of the late Sir Charles Parsons, O.M., K.C.B., F.R.S. This Association will be open to old employees of C. A. Parsons and Co., Ltd., The Parsons Marine Steam Turbine Company, Ltd., as well as to present members of these firms, both at home and abroad. Would all those interested in the formation of such an Association kindly write to the Hon. Secretary, Parsons Association, care of C. A. Parsons and Co., Ltd., Heaton Works, Newcastle-on-Tyne, when further particulars will be sent.

THE INSTITUTION OF CIVIL ENGINEERS' AWARDS.—The Council of the Institution of Civil Engineers has recently made the following awards in respect of papers read and discussed at the ordinary meetings during the session 1930–31:—A Telford Gold Medal to Mr. W. T. Halcrow, M. Inst. C.E. (London); Telford Premiums to Mr. F. R. Freeman, B.Sc., M. Inst. C.E. (London); Mr. G. C. Minnitt, Assoc. M. Inst. C.E. (Bombay); jointly to Mr. C. S. Berry, M. Inst. C.E., Mr. H. P. Gaze, M. Inst. C.E., and Mr. C. E. H. Verity, Assoc. M. Inst. C.E. (London); and jointly to Professor A. H. Gibson, D.Sc., M. Inst. C.E. (Manchester), Mr. T. H. Aspey, M.Sc. (Wigan), and Mr. F. Tattersall, M.Sc. (London). A Manby Premium to Mr. A. B. Ellison, M. Inst. C.E. (Nag Hammadi, Egypt). A Crampton Prize to Mr. R. T. McCallum, O.B.E., B.Sc., M. Inst. C.E. (Derby). The Council would have awarded a Telford Premium to Mr. Percy Allan, M. Inst. C.E. (Sydney, N.S.W.) had he been still living.